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ANNALS
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Volume XXXI MARCH, 1938 No. 1

A NEW NORTH AMERICAN SPECIES OF CRABRO (HYMENOPTERA: SPHECIDAE)

GRACE ADELBERT SANDHOUSE,
Bureau of Entomology and Plant Quarantine,
United States Department of Agriculture

Recently several specimens of an apparently undescribed species of *Crabro* have been received for identification and, since a name is required for use in connection with studies of its habits, a description is given below.

Crabro (Blepharipus) davidsoni, new species

In the key by Fox to the Crabroninae of boreal America (Trans. Amer. Ent. Soc., 22 : 129–226. 1895), the female runs to *cinctipes* (Provancher) in couplet 75, but in that species the clypeus has a median carina and a subtruncate, produced, median portion. According to the characters given in the key to the males and by Provancher in his original description, the male of *cinctipes* does not have the front tarsus modified as in the present species.

Female.—7 mm. long. Shining black with the following parts yellow: Base of mandible, front and middle basitarsi, bases of middle and hind tibiae, and a stripe on the scape and one on the front tibia. Wings subhyaline, iridescent. Tegula and veins brownish testaceous. Pubescence silvery white, rather sparse, except on the clypeus, which is densely covered. Punctures fine, rather indistinct and sparse, a little coarser on the mesonotum.

Head, seen from above, narrowed gradually behind the eyes to occipital carina, in facial view about one and one-half times as wide as long. Eyes large, inner margins converging strongly below and touching antennal foramina, which are contiguous. Lower part of face greatly narrowed, just above the foramina less than combined length of flagellar joints 1 and 2, impunctate, slightly concave; from above this concavity a narrow median furrow extends to the anterior ocellus. Supraorbital

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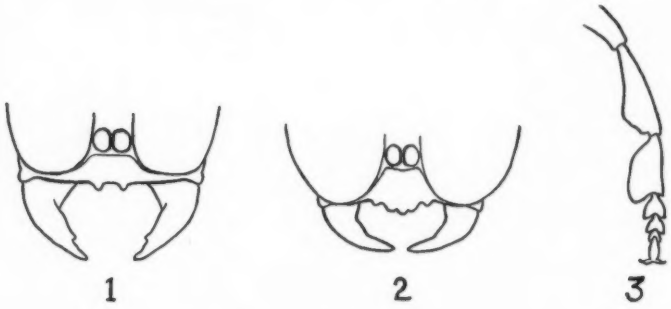
fovea shallow, subtriangular. Vertex without modification. Ocelli arranged in an equilateral triangle; postocellar line about half as long as ocelloccipital line. Occiput concave and fitting against anterior part of prothorax. Greatest width of clypeus nearly four times median length; apical margin subtruncate, medially bidentate (fig. 1), the teeth separated by a sub-semicircular emargination. Gena extending back behind the eye for a short distance, then gradually declivous to occipital carina, which becomes obsolescent on lower half of gena. Apex of mandible tridentate, middle tooth only a little longer than inferior, and much longer than superior tooth. Labial palpus 4-jointed, maxillary palpus 6-jointed.

Pronotum with a shallow transverse sulcus near posterior margin, but neither transversely carinate anteriorly nor dentate laterally.



Crabro (*Blepharipus*) *davidsoni* n. sp.

Fig. 1. Clypeus of female. Fig. 2. Clypeus of male.
Fig. 3. Front leg of male.

Mesothorax and metathorax normal for the subgenus. Dorsal surface of propodeum with a suboval glabrous enclosure which is bordered laterally and posteriorly by a weakly foveolate groove and divided by a median longitudinal furrow; posterior-lateral angle carinate on lower half only; posterior surface smooth, with a rather broad median furrow below enclosure; space between posterior-lateral carinae weakly carinate. Venation typical for the subgenus; first abscissa of radius three-fourths as long as second.

Anterior-lateral angle of front coxa produced laterally into a sharp tooth. Front femur with anterior surface slightly convex and posterior surface angulate, so that in cross-section it is nearly triangular. Front basitarsus longer than combined length of remaining joints, inferior margin with several spines which are about as long as second joint. Middle and hind legs unmodified; middle basitarsus a little longer than combined length of remaining joints, hind basitarsus subequal to them.

Shape of abdomen typical for the subgenus. Tergites very indistinctly punctured and finely aciculate. Pygidial area polished, with a

few coarse punctures on basal portion; width at base four times that at apex; lateral carina converging from base to near apex, subparallel for only a short distance before apex.

Male.—6 mm. long. Black, with the following parts yellow: Upper part of basal half of mandible; front tibia, excepting a dark spot on posterior surface; extreme bases of middle and hind tibiae; a stripe on scape. Front tarsus ivory white; basitarsus irregularly mottled with black, second joint with an elongate black spot just before base of third joint. First and second joints of middle tarsus whitish, extreme apices black.

In general characters similar to the female, but a little more slender and with the usual sexual differences. Head behind eyes more abruptly narrowed to occipital carina, which is rather strongly developed, especially at the sides. Ocelloccipital line only a little longer than postocellar line. Flagellum unmodified, second joint longest, third to sixth joints progressively shorter, those apicad subequal in length. Apical margin of clypeus with a median produced portion which has a low median tooth (fig. 2). Gena with a row of strong foveae in front of occipital carina. Mandible bidentate, the teeth subequal. Propodeum with a more deeply foveolate groove bordering enclosure; apical-lateral angle foveolate above carina; transverse carinae on posterior surface stronger. Wings similar to those of female, but first abscissa of radius about five-eighths as long as second. Front leg rather strongly modified (fig. 3); basal two-thirds of coxa narrow, then widened abruptly to form an angle, apical portion more than twice as wide as basal; femur rather similar to that of female, but abruptly narrowed at base; tibia narrowest at base, then gradually widened along the inferior margin to form a broadly rounded projection which is widest about one-third the distance from apex, inner surface of projection beset with rather long and slightly curled hairs; tarsus flattened and expanded, basal joint narrowest at base, its greatest width about one-half its length, upper margin straight, joints 2 to 4 subcordate, bilaterally symmetrical, progressively narrower. Middle and hind legs unmodified, in each the basitarsus subequal to the combined length of joints beyond. Abdomen rather slender; apical margin of seventh tergite strongly convex; sternites unmodified, apical margins truncate.

Type locality.—Columbus, Ohio.

Types.—Holotype, female, and allotype, male, United States National Museum, No. 52,048. Paratypes from Montreal, Quebec, in Canadian National Collection.

Described from 15 specimens: The type and allotype taken by R. H. Davidson at Columbus, August 8, 1935, and bearing the number 2749; 2 females and 1 male, bred from wood by J. S. Houser, at Wooster, Ohio, August 19, 1936; 4 males bred from a peach stump by B. J. Landis, at Greenville, Ohio, April 25, 1934; 2 females, Chicago, Illinois, June 11, 1927 (No. 80) and August 22, 1928 (No. 128) (H. Brun); 1 female,

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Rochester, New York, June 23, 1933 (M. G. Jeffers); 1 female, Woodstock, Maryland (No. 236,116) (E. G. Reinhard); 1 female and 1 male, Montreal, Quebec, 1924 (J. W. Buckle). This material exhibits variation in color only in that the pronotum is sometimes obscurely yellowish in the middle.

STATISTICAL METHODS APPLIED TO EXPERIMENTS IN AGRICULTURE AND BIOLOGY, by G. W. SNEDECOR. pp. i-ix and 1-341, 21 text figures, 128 tables, 397 examples. 1937. Collegiate Press, Inc., Ames, Iowa. Price, $3.75.

Mathematics and mechanical drawing are no more important to the engineer than are statistical methods to the experimental entomologist. Yet it is only in recent years that entomologists have become fully conscious of the necessity for dealing with biological variation in a quantitative way, both in the design of experiments and in the expression of results with their probable significance. The few entomologists who were able to delve into statistical literature and bring forth methods suitable for their work were generally regarded with respect and envy by their less gifted colleagues, who pleaded to be led through the statistical wilderness. Attempts have been made to lead them by statisticians who had penetrated so far that they could not make contact with novices. Their cry for help has at last been heard by a statistician who knows both the needs and the mathematical limitations of the average entomologist. Thanks to his years of collaboration with the biologists of Iowa State College and to his ability as a teacher, Professor Snedecor has been able to write a book on statistical methods for biologists that is the answer to the entomologists' prayer. Any entomologist endowed with common sense and the ability to calculate an arithmetic mean can provide himself with a firm statistical foundation for his work by diligent study of this book and by working out the problems contained in it. With this book available no entomologist can find a legitimate excuse for failing to learn the elementary workmanship of experimentation. Professor Snedecor's book will undoubtedly speed the day when experiments will always be designed for efficient quantitative expression of results and their probable significance. Then such statistical procedures will be regarded as a matter of course and those who do not understand them will not be doing experimental work.

Professor's Snedecor's book is written in attractive conversational style, as if prepared from shorthand notes of his lectures. He introduces the subject in an unexpected way. Instead of dealing first with continuous variation and means of measuring it in relation to the normal frequency distribution curve, he considers enumerational statistics in which one is concerned with two attributes of the individuals of a population; e. g., dead or alive, male or female, and he demonstrates the use of chi-square as a measure of variation of such data. Then he turns to continuous variation in dimensions or weight and develops the subject from the bottom on the basis of variation of differences between pairs. After making clear the meaning of standard error and its use in testing for significance of a mean difference, he goes on to consider group comparisons in which the means of two groups of data are obtained instead of the mean of differences between pairs. A good discussion of "pairing" vs. "pooling" is given. The rest of the book is devoted to methods for handling more than one variate at a time or more than one pair of attributes. Linear, curvilinear, and mutliple regression, correlation, analysis of variance and covariance are among the topics discussed. Exact directions for computations and numerous examples are given throughout the book. Many examples are drawn from field and laboratory work of economic entomologists.

Sections of chapters, figures, tables, and examples are numbered by chapters, the number preceding the decimal point being the number of the chapter. The information presented is well organized and clearly printed, and the book appears to be rugged enough to withstand the handling necessary to master it.—F. L. C.

CRABRO DAVIDSONI SANDH., A WASP PREDACIOUS ON ADULT LEAFHOPPERS

R. H. DAVIDSON AND B. J. LANDIS,
Bureau of Entomology and Plant Quarantine,
United States Department of Agriculture

Specimens of a crabronid wasp reared from an old peach stump collected at Greenville, Ohio, April 1, 1934; from a rotting fence post near Columbus, Ohio, during the summer of 1935,[1] and from a porch near Wooster, Ohio, during the summer of 1936[2] were described by Grace Sandhouse as *Crabro* (*Blepharipus*) *davidsoni* in the preceding article (p. 1).

In each of the three localities in which *Crabro davidsoni* was collected, the larval stages were observed to have developed on quantities of leafhoppers stored in galleries made in dead wood. The galleries were long and winding and penetrated both hard and decayed wood. Each gallery contained many cells which were provisioned almost entirely with adult leafhoppers packed side by side with the heads in the same direction, except for an occasional specimen laid cross-wise at the caudal ends of those arranged in a row, thus serving to level the stack. In a few cases the cells contained forms other than adult leafhoppers. A few dipterous puparia were found in one cell, a syrphid fly and several anthomyiid flies in another, and in one instance a few leafhopper nymphs. The dipterous puparia may have been of some scavenger or parasite.

The cells containing leafhoppers were from one-fourth to one-half inch in length and were delimited by small plugs of chewed wood. The number of individuals in 47 cells examined ranged between 4 and 46 and averaged 20.4 leafhoppers. Cells containing species of large leafhoppers contained fewer individuals than cells containing smaller individuals. Apparently the leafhoppers were rendered immobile by stinging before being placed in the cells, and some individuals retained the original coloration and limp condition after six or more months. In the cells in which the *Crabro* larvae developed only pieces of the exoskeleton remained.

---

[1]Collected August 2, 1935, by D. J. Borror, Ohio State University.

[2]Received by J. S. Houser, of the Ohio Agricultural Experiment Station and relinquished to J. N. Knull, of Ohio State University. Specimens dated August 19, 1936.

Leafhopper specimens which still retained their original color were identified by color and by the chitinous pieces of the male genital chamber. In faded specimens, the leafhoppers in each cell were grouped according to size and coloration (if any color was present) and the genitalia of the males of each group were used as a basis for the identification.

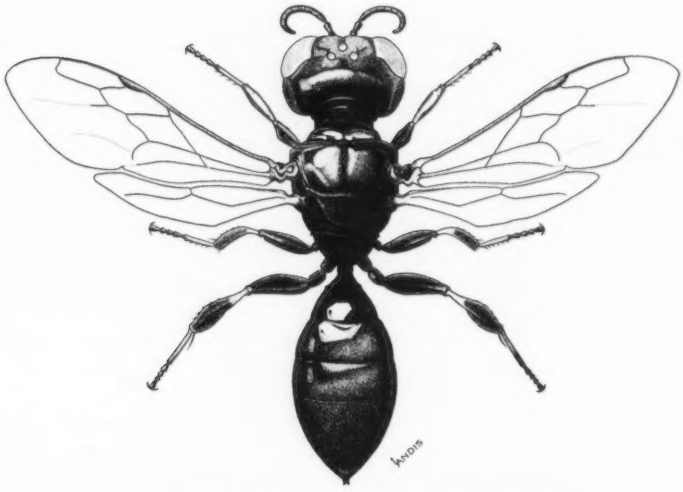

Fig. 1. Adult of *Crabro* (*Blepharipus*) *davidsoni* Sandhouse.

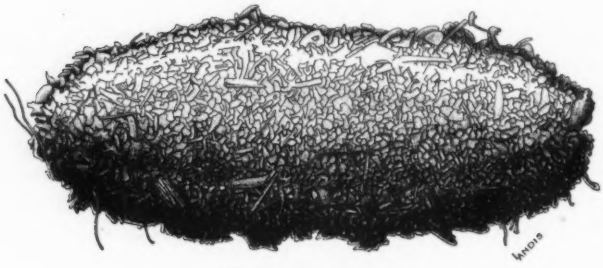

Fig. 2. Cocoon stage.

No larvae of *Crabro davidsoni* were found in the cells but there was evidence that in some instances the larvae, apparently having exhausted the food in one cell, moved through the plug of wood pulp into another cell where development was completed. The cocoons (Fig. 2) were formed within the galleries

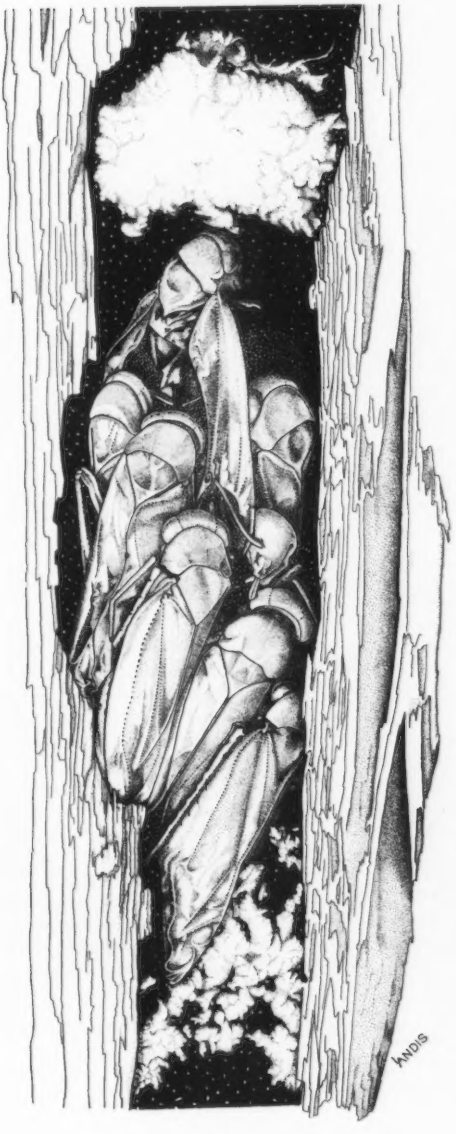

Fig. 3. Drawing of leafhoppers stored in pieces of rotting log by *Crabro* (*Blepharipus*) *davidsoni* Sandhouse.

and consisted largely of pieces of the exoskeletons of the leafhoppers fed upon (Fig. 3). Fifteen adults (Fig. 1) emerged in the laboratory between April 14 and May 1 from cocoons collected April 1. The adults lived from 8 to 15 days under cage conditions and fed on raisins and loaf sugar. At night they entered a darkened glass vial which was attached to the cage.

An examination of several hundred leafhoppers found in the cells of *Crabro davidsoni* showed the food to be restricted to the genera *Typhlocyba*, *Erythroneura*, and *Empoasca*. Of 33 leafhoppers in one cell from Greenville, Ohio, 24 were *Erythroneura comes* (Say),[3] 7 *Typhlocyba rosae* (L.), 1 *Erythroneura vulnerata* Fitch, and 1 *Empoasca fabae* Harris. Of 38 leafhoppers in one cell from Columbus, Ohio, 21 were *Typhlocyba rosae* (L.), 6 *Empoasca fabae* Harris, 3 *Erythroneura lawsoniana* Baker, 4 *Erythroneura dowelli* Beamer, 1 *Typhlocyba australis* Frogg, 1 *Erythroneura hartii* (Gill.), and 2 *Erythroneura magnacalx* Beamer. Leafhoppers obtained from cells collected near Wooster, Ohio, were found to be *Empoasca bifurcata* DeL., *E. fabae* Harris, *Empoasca* n. sp., and *Erythroneura confirmata* McAtee.

The following is a list of the species of leafhoppers found in cells of *Crabro davidsoni* collected at Greenville, Columbus, and Wooster, Ohio:

Empoasca alboneura Gill.
Empoasca bifurcata DeL.
Empoasca birdii Godg. 1890
Empoasca erigeron DeL.
Empoasca fabae Harris
Empoasca gelbata DeL. and Dav.
Empoasca maligna Walsh
Empoasca, n. sp.
Empoasca obtusa Walsh
Empoasca patula DeL.
Empoasca solana DeL.
Empoasca nymphs
Typhlocyba gillettei V. D.
Typhlocyba pomaria McAtee
Typhlocyba rosae (L.)
Typhlocyba australis Frogg.
Typhlocyba modesta Gibson
Typhlocyba melite McAtee
Erythroneura comes (Say)
Erythroneura confirmata McAtee
Erythroneura dowelli Beamer
Erythroneura lawsoniana Baker
Erythroneura tricincta Fitch
Erythroneura vulnerata Fitch
Erythroneura ziczac Walsh
Erythroneura lawsoni Robinson
Erythroneura vitis (Harris)
Erythroneura hartii (Gillette)
Erythroneura magnacalx Beamer
Erythroneura elegans McAtee
Erythroneura rubra (Gillette)
Erythroneura albescens Beamer

[3]The authors are indebted to Mrs. Josef N. Knull for determining the *Erythroneura* and *Typhlocyba*.

A MODIFIED WRIGHT'S BLOOD-STAINING PROCEDURE FOR SMEARS OF HEAT-FIXED INSECT BLOOD

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A number of authors have reported investigations either on insect blood or at least involving a study of insect blood (hemolymph). Many of these publications[2] have included observations or data on the occurrence of various types of insect blood cells. Some have included descriptions of the use of fixed and stained smears of insect blood (2, 3, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23).[3] A few (3, 6, 12, 14, 17, 22, 23) have contained values for the percentages of certain cell types in the blood-cell populations that were studied. Most of the investigations utilizing insect blood smears, however, have indicated little recognition of the factors that must be considered to influence the insect differential blood-cell count. These are similar to the factors recognized as influencing the mammalian differential blood-cell count plus those resulting from the characteristic tendency of many of the insect blood cells to undergo rapid and drastic morphological transformations at the time of blood sampling and blood smearing.

PASSIVE-ACTIVE TRANSFORMATION

These form changes are the characteristic cell transformations that occur during the process of "cell coagulation" of insect blood (23, 24) and are similar to the reversible transformations from passive to active state described by Fauré-Fremiet (2) and others (referred to in his paper) in connection with the blood cells of marine invertebrates. The passive form is the form assumed by the cell when it is in a resting state and not involved in special cytological activities, as, for example, spreading on a surface. The passive or resting cell is characterized by the possession of a relatively unchanging shape and by certain protoplasmic properties that thus far have received investigation almost entirely among invertebrates other than insects. It may be assumed that, in general, the insect blood cell tends to assume its passive form while it is being transported by the circulating blood. The active form is exhibited by the cell when it is undergoing its particular cytological activity, such as migration along tissue and other surfaces, cell coagulation, or certain modes of phagocytosis. A cell that is transforming into the active state is characterized by a decidedly unstable and varying form and by certain physico-chemical conditions of protoplasm

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[1]The author was assisted in this work by Mr. James B. Gross.

[2]It is not convenient in this paper to refer to all the existing publications that relate to the subject of insect blood.

[3]Numbers in parentheses refer to "Literature Cited," p. 13.

(especially of cytoplasm) that differ markedly from those of the same or of another cell in the passive state. The active form has been called choanoleucocyte, first by Dehorne (1) and later by Fauré-Fremiet (2), both of whom utilized invertebrates other than insects. The passive and the active forms may be so entirely different in appearance as to be easily mistaken for different morphological cell types. A number of experiments by the author indicate that the choanoleucocytic form occurs in insects and that the active-passive transformation is as truly characteristic of insect bloods as it is of the bloods of marine invertebrates.

The following factors may be considered to offer greatest interference with the obtaining of reproducible and significant differential cell counts from air-dried smears of unheated insect blood stained with Wright's blood stain in the customary manner: (*a*) The loss of the passive cell form caused by the tendency of many insect blood cells to round up and eventually to assume the active or choanoleucocytic (1) form with lamellar or other type of pseudopodial extension (2, 5); (*b*) the decreased visibility of cytological detail resulting from the earlier, rounding-up phases of the passive-active transformation and from (*c*); (*c*) the cell agglutination and cell distortion associated with the passive-active transformation and greatly accentuated by the mechanical disturbance of smearing the drop of blood on the slide; and (*d*) the consequent failure to obtain a blood smear possessing a random distribution of cells

FIXATION

To eliminate these disturbing factors from the insect-blood-smearing and differential-counting techniques, it is necessary to prevent the passive-active transformation. This can be done by fixing, in the histological sense, blood cells either before sampling or at the time of sampling. Fixation prior to sampling can be readily accomplished by subjecting the living insect to immersion in water at 60° C. for 5 to 10 minutes (23) or to acetic acid vapor for a sufficient length of time (20, 21). These treatments usually cause the death of the insect. To fix the blood cells at the time of sampling, the blood from the living insect can be collected during the sampling procedure into an appropriate histological fixing fluid. This involves, however, undesirable dilution of the blood and, possibly, selective loss of cells from the smear during subsequent staining procedures. From the standpoint of smear preparation, one of the most satisfactory procedures is to immerse the insect in water of such temperature and for such length of time that the blood cells are fixed while the plasma proteins are not visibly (i. e., microscopically) precipitated, which are usually about 55–60° C. and from 5 to 10 minutes, depending upon the species of insect. After the otherwise undisturbed blood is thus fixed, it can be sampled and smeared at leisure in the absence of the interfering factors that have been mentioned. Unfortunately, however, there arises one other undesirable condition. As a rule, the heat-fixed cells do not exhibit satisfactory differential staining or clear cytological details when stained with Wright's blood stain applied in the customary manner.

STAINING PROCEDURE

In an effort to overcome this difficulty and to obtain satisfactorily stained smears of heat-fixed insect blood, a large number of modifications of the usual Wright's blood-staining procedure were investigated. Although most of the modifications that were tried yielded unsatisfactory staining of the heat-fixed cells, eventually a modification, here designated as the Wright-nicotine-oxalic acid technique, was devised and has proved successful. A description of the fixing and staining procedures adapted to southern armyworm larvae, *Prodenia eridania* Cram., follows:

Step 1: The insect is heated at 55° C. for 5 minutes by immersion in water heated to that temperature.

Step 2: The insect is removed from the water and thoroughly dried.

Step 3: One of the insect's legs is severed and the blood collected as a large drop upon a clean slide.

Step 4: A small drop of the collected blood is immediately used to make an air-dried smear in the customary way.

Step 5: The dried smear is flooded with undiluted Wright's blood stain for 1.5 minutes, and then diluted for 3.5 minutes with an equal volume of aqueous 2.5 percent nicotine solution, freshly prepared.

Step 6: The nicotine-diluted Wright's stain is poured off, and the smear is carefully washed with four medicine droppers full of distilled water.

Step 7: The smear is immediately blotted and dried carefully over a small flame.

Step 8: The slide is quickly dipped from two to four times in 70 percent ethyl alcohol until just the desired amount of dye is removed from the smear.

Step 9: The smear is blotted at once and carefully dried over a flame.

Step 10: The smear is flooded with 0.0006 percent oxalic acid solution in distilled water for 1 to 2 minutes.

Step 11: The smear is quickly blotted and carefully dried over a flame.

Step 12: The smear is permanently mounted in balsam under a coverslip.

This technique requires careful handling and should be slightly altered to suit the particular insect blood and the particular batch of Wright's blood stain, the variability of which is generally recognized, that are being used. The Wright's blood stain is prepared as usual by dissolving the dye powder in pure (acetone-free) methyl alcohol but at twice the concentration usually employed. The solution is then refluxed for 6 or 7 hours, poured into a clean container to eliminate any sediment in the bottom of the refluxing flask, and allowed to cool to room temperature before use. The nicotine solution is prepared by dissolving 2.5 cc. of the pure redistilled alkaloid in 97.5 cc. of distilled water. In step 4 the collected blood should not be allowed to stand for more than a few seconds before the smear is made; otherwise cell sedimentation will interfere with the obtaining of a representative sample of the insect's blood-cell population. Especially do the durations of application of the undiluted and the nicotine-diluted Wright's stain require careful adjustment. The *exact* amount of dipping in the 70 percent alcohol in step 8 should be carefully determined. The degree of staining should be roughly checked at steps 7 and 11 by microscopic observations of the *drying* or *dried* smear. The cytological details and

staining effects are more clearly visible in the smear before than after it is completely dried. To obtain consistently satisfactory results, each smear should be run through the procedure separately.

Once the procedure is thus adjusted to a given batch of stain and to a given insect blood, good differential staining of the heat-fixed cells can be obtained consistently.

DISCUSSION

The Wright-nicotine-oxalic acid technique is being utilized in a study of the heat-fixed blood of the southern armyworm, *Prodenia eridania* Cram., practically all the cells of which exhibit eosinophilic nuclei, cytoplasms of various degrees of vacuolization, and basophilia, and sometimes eosinophilic and phagocytized cytoplasmic inclusions. Since the studies of *Prodenia eridania* blood will be reported in another paper, the various blood-cell types of that insect will not be described here. This technique has been used successfully also with the heat-fixed bloods of the following species of insects: Japanese beetle, *Popillia japonica* (adult, larva); May beetle, *Phyllophaga* sp. (larva); cockroach, *Periplaneta americana* L. (adult, nymph); cabbage looper, *Autographa brassicae* Riley (larva); cross-striped cabbage worm, *Evergestis rimosalis* Guen. (larva); cabbage webworm, *Hellula undalis* Fab. (larva); and diamond-back cabbage moth, *Plutella maculipennis* Curt. (larva). Smears of unheated blood of *Prodenia eridania* are also well differentially stained by this method; the cells, of course, exhibit more or less the active forms, agglutination, and mechanically produced deformations. It has also been used successfully with the heat-fixed bloods of the American lobster, *Homarus americanus* (adult), and a fresh water crayfish, as well as with smears of heat-fixed blood and lymph obtained from an earthworm and smears of frog blood (unheated).

When smears of heat-fixed and smears of acetic acid-vapor-fixed blood of *Prodenia eridania* larvae are stained in a similar manner with the Wright-nicotine-oxalic acid procedure, they exhibit differences in staining effect. In general, the acid-fixed cells appear to be more washed out and to stain less intensely than the heat-fixed cells, the acid-fixed nuclei may frequently appear more conspicuous within the cell, and the cytoplasmic vacuoles often appear larger and more distinct in the acid-fixed than in the heat-fixed cells. Certain observations, however, indicate that, at least in the case of this large larva, heat fixation results in a truer preservation of the normal blood picture, in spite of certain desirable features of the acid fixation, in that the heat-fixed cells tend more to retain their circulating (passive) forms with a minimum of alteration. It is generally recognized (11) that acetic acid is a histological fixative that may produce considerable alteration of protoplasmic details, especially when used alone. For these reasons the heat fixation is here considered preferable for the general purposes of differential-blood-cell counting.

In order to compare the results obtained with the Wright-nicotine-oxalic acid technique with the well-known results obtained by means of the usual Wright's blood-staining procedure, air-dried smears of human blood (not heat-fixed) were treated in both ways. The results were

much the same, except that the eosinophiles appeared somewhat more brilliant and the erythrocytes sometimes assumed a greenish rather than the usual reddish tint when the Wright-nicotine-oxalic acid technique was employed, and that in general a slightly improved cytological differentiation seemed to occur in most of the stained leucocytes.

These observations indicate that the Wright-nicotine-oxalic acid technique can be successfully applied, not only to smears of insect blood, but also to blood smears of other invertebrates and vertebrates, whether or not the blood has been fixed with heat.

Summary

Insect blood cells, like the blood cells of other invertebrates, exist in the passive and the active states and exhibit passive-active morphological transformations.

The influence of the passive-active form-changes upon insect-blood-smearing and differential-cell-counting techniques is discussed.

When smears of heat-fixed insect blood are treated according to the usual Wright's blood-staining procedure, they generally do not exhibit satisfactory color differentiation or finer cytological details.

A modified Wright's technique, called the Wright-nicotine-oxalic acid technique, for use with heat-fixed insect blood is described.

This technique has been used successfully upon the heat-fixed bloods of a number of different insect species and of several other invertebrates, as well as upon smears of unheated frog, human, crayfish, and southern armyworm blood. When applied to smears of human blood, the Wright-nicotine-oxalic-acid technique yields a cytological differentiation slightly superior to that obtained with Wright's blood stain applied in the customary manner.

It is concluded that the Wright-nicotine-oxalic acid technique is generally applicable to invertebrate (heated or unheated) or vertebrate (unheated) bloods.

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A NEW SPECIES OF BRACONIDAE FROM FLORIDA (HYMENOPTERA)

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Iphiaulax manteri n. sp.

Female.—Length 6.6–8.4 mm. Head, labial and maxillary palpi, antennae, thorax, legs, and ovipositor sheaths black. Abdomen a dark orange-red, occasionally mottled with black between the segments. Ovipositor concolorous with the abdomen.

Head subquadrate, a little wider than long; antennae as long as the body and with 58 segments; ocell-ocular line 2½ times the diameter of the largest ocellus; lateral-ocellar line as long as the diameter of the largest ocellus; malar space as long as the basal width of the mandibles; a well defined suture extends from the median ocellus to between the antennae; and an impunctate mesal area on the face below the antennae.

Thorax about twice as long as broad, impunctate, smooth and polished; parapsidal furrows distinct, except at the extreme apical portion of the mesothorax where they do not converge; scutellum large, triangular with its apical portion rounded; propodeum wider than long, smooth and shiny, and somewhat pilous. Wings dark infuscated, with a narrow hyaline band across the first cubital cell, connected with a hyaline spot below the base of the second cubital cell; tegulae dark-brown, polished; and stigma dark-brown, subtriangular. All the legs black and moderately pilous; hind coxae three times as large as the fore or middle coxae; all femorae two-thirds as long as the tibiae; tarsi as long as the tibiae; tibial spurs subequal, the inner one a little longer; hind femorae slightly stouter than the fore or middle femorae; and the second tarsal segment as long as the fifth.

Abdomen broadly ovate, the apical tergites black (either tergites 6, 7, and 8, or just 7 and 8); suturiform articulation broad, deep and crenulate; first tergite with two crenulated lateral longitudinal furrows, and a median embossed area, the apical half of which is rugulose; at the basal middle of the second tergite is a small, smooth, shield-shaped area and on each side of this area are two deep lateral oblique furrows, the latter having their bottoms either black or orange-red; and the ovipositor is about one-fifth the length of the abdomen.

Male.—Length 7.4 mm. Agrees well with the female, except in the usual sexual differences, having the abdomen lighter in color, and only the apical half of the sixth tergite black.

This species is closely related to *Iphiaulax divinator* Cameron and *Iphiaulax molestus* Cameron, both of these having Guate-

[1]Contribution from the Department of Entomology, Massachusetts State College.

mala as their type locality. It is distinguished from *Iphiaulax divinator* Cameron by having the apical joint of the palpi black and the antennal segments approximately equal in size. It differs from *Iphiaulax molestus* Cameron by having the wings darker, the abdominal tergites six to eight black (or seven and eight) instead of four to eight as in *Iphiaulax molestus* Cameron, and the distinctly raised ocellar area which is indistinct in *Iphiaulax molestus* Cameron. In respect to the New England species, such as *Iphiaulax agrili* Ashmead, *Iphiaulax augustus* Viereck, *Iphiaulax eurygaster* Brullé, and *Iphiaulax erythrogaster* Brullé, this species is readily distinguished by the much deeper and more distinct crenulation of the abdominal furrows, the larger number of antennal segments (58 as compared with about 47 for those four species listed above), the much darker wings in this species, and the apical tergites of the abdomen being black whereas those four species mentioned have the abdomen wholly orange-red.

Described from holotype female and allotype male, the female being collected at Gainesville, Florida, on the 26th of April, 1934, and the male being collected at the same place on April 10, 1925. (Paratype females were collected by H. T. Fernald at Orlando, Florida, March, 1925).

SOURCE BOOK OF BIOLOGICAL TERMS, by AXEL LEONARD MELANDER. Pages i-v and 1-157. Published by Department of Biology, The City College, The College of the City of New York, Convent Ave., at 138th St., New York, N. Y. Price, $1.10 each, with sliding scale down to $0.75 each for 35 copies or more.

This source book is one of those very useful working conveniences which has simply grown up under the necessity of having a working list of roots for the interpretation of scientific terms. The first part, pages 1-60, is an interesting discussion of terms, the evolution of word meanings, pronounciations, mispronunciations, etc. The second part is a lexicon of roots and root words used in building a biological vocabulary. With the biological term in hand its meaning is easily found. The work is thus an informative dictionary. It adds to what the student already knows. It gives the English of the original meaning of the Latin or Greek word. A book of this type has sales value in an institution of students who are easy masters of language. A previous, mimeographed list has had wide distribution in New York City collegiate institutions.

The reviewer has wished for just the opposite type of lexicon, one with the main list in English terms followed by the Latin and Greek equivalents, an English-Latin and English-Greek dictionary. Our problem is, after thinking up an appropriate name for a new species of insect to try and find its Latin or Latinized Greek equivalent. The average American biologist thinks from English into Latin or Greek. The problem Professor Melander has tackled from its very nature reverses the usual mental process. It is an interesting and excellent explanation of what already exists.

The book is well bound. It can be recommended to all men who expect to be immersed in biological terms until they are retired by a pension service.

—C. H. K.

SOME REVISIONS IN THE GENUS SPHEX, WITH ONE NEW SPECIES, A NEW SUBSPECIES, AND A NEW NAME (HYMENOPTERA: SPHECIDAE)[1]

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The North American and West Indian wasps of the genus *Sphex* were monographed by Dr. H. T. Fernald in 1934. In this monograph little study was made of the male genitalia. The writer has made a study of the male genitalia and has found them to be of the greatest importance in determining the validity of the species in this genus. In the first place, they are frequently vastly different in otherwise apparently identical species. In the second place, they are frequently the only means of defining the limits of a variable species.

Aside from the male genitalia, one of the most important specific characters is a structure designated herein as the metanotal flange. This is a thin, almost membranous process, with a texture similar to that of the tegula. It is entirely absent in many species. When present, it may be small, moderate, or large in size, and may or may not be emarginate. It begins below and extends behind the hind wing on the metanotum, and is best seen from a side view of the thorax. For best observation, the wings should be in a normal resting position and not spread sideways.

The shape of the clypeus and the position of the clypeal teeth are of much importance in both males and females. Color is an unreliable character to use, but can nevertheless be used to advantage when one has a complete understanding of a species.

In this study the writer has used principally the collection of the University of Minnesota. The collections of Utah Agricultural Experiment Station and of Oklahoma Agricultural College, and part of the collections of Oregon Agricultural College and of Iowa Wesleyan College have also been studied. Cresson's types of *vulgaris*, *mediata*, *inepta*, *extremitata*, Fernald's holotype of *pilosus* and paratypes of *floridensis*, *aculeatus* and

[1]Paper No. 1516 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.

transversus, all located in the collection of the American Entomological Society at Philadelphia, and Fernald's holotypes and allotypes of *aculeatus* and *floridensis* and holotype of *transversus*, located in Dr. Fernald's collection, have been examined.

KEY TO SPECIES DESCRIBED IN THIS PAPER

(See Plate I for figures of male genitalia.)

1. Males 2
   Females 12
2. Episternal suture long, extending well down to the underside of the body ... 3
   Episternal suture short, ending about opposite the prothoracic lobe 7
3. Collar rising almost vertically from the neck for a short distance, then turning backwards quickly to form an almost flat, rather long, sloping, dorsal surface; teeth of clypeus prominent, blunt, rather far apart; no metanotal flange; scutellum longitudinally ridged. (Page 22) ..... **arvensis**
   Collar rising quite slopingly from the neck to the highest point, or rising from the neck to the highest point in a smooth arc 4
4. Thorax with black pilose hairs; wings fuliginous, with a yellowish tinge; no metanotal flange; ridges of propodeal side running only slightly forward or curving forward on anterior part only. (Page 19) ..... **fernaldi**
   Thorax with at least some white pilose hairs; wings fuliginous or hyaline, but without a yellowish tinge; with or without a metanotal flange 5
5. Head pilosity black; clypeus broadly rounded with a slight central emargination; without a metanotal flange. (Page 24) ..... **mediatus**
   Head pilosity white; clypeus toothed, emargination between the teeth moderate; with a moderate to large metanotal flange (in occasional specimens only a trace or rarely none at all) 6
6. Pleura with sericeous hairs short and inconspicuous. (Page 28), **pilosus** subsp. **nudus**
   Pleura more or less heavily sericeous. (Page 26) ..... **pilosus** subsp. **pilosus**
7. Pilosity of thorax black. (Page 19) ..... **fernaldi**
   Pilosity of thorax white 8
8. Clypeal margin broadly truncate, sometimes with a weak central emargination. (Page 41) ..... **aberti**
   Clypeal margin not broadly truncate; margin always with a distinct central emargination 9
9. Metanotal flange very large, reddish; prothoracic lobe, and sometimes areas of the pro-, meso-, and meta-pleura, reddish; clypeus with two rounded lobes, the emargination between the lobes shallow. (Page 29) ..... **leopardus**
   Metanotal flange small or absent; prothoracic lobe and pleura entirely black; clypeus toothed, the emargination between the teeth rather deep ... 10
10. Costa of fore wing at base distinctly amber in reflected light; a very slight metanotal flange; first expanded dorsal abdominal segment entirely red. (Page 36) ..... **kennedyi**
    Costa of fore wing at base black in reflected light; no metanotal flange whatever; first expanded dorsal abdominal segment red with a black dorsal band 11
11. Wings rather strongly fuliginous; size large. (Page 36) ... **urnarius floridensis**
    Wings lightly to moderately fuliginous; size medium to small. (Page 30), **urnarius**
12. Episternal suture long 13
    Episternal suture short 17
13. Collar rising almost vertically from the neck for a short distance, then turning backwards quickly to form an almost flat, rather long, sloping, dorsal surface; no metanotal flange; scutellum longitudinally ridged. (Page 22) ..... **arvensis**
    Not so, collar rising quite slopingly from the neck to the highest point, or rising from the neck to the highest point in a smooth arc 14

14. Wings yellow; scutellum not coarsely longitudinally ridged, with fine striae on posterior part only; thorax with no white pubescence (except rarely on each side of petiole attachment). (Page 19)..... **fernaldi**
Wings not yellow; scutellum coarsely longitudinally ridged; thorax with at least some white sericeous or pubescent hairs.....15
15. Head pilosity black; eyes parallel; without a metanotal flange. (Page 24), **mediatus**
Head pilosity white; eyes slightly but distinctly convergent below; with a moderate to large metanotal flange (in occasional specimens only a trace or rarely none at all).....16
16. Pleura with sericeous hairs short and inconspicuous. (Page 28), **pilosus** subsp. **nudus**
Pleura more or less heavily sericeous. (Page 26)..... **pilosus** subsp. **pilosus**
17. Legs partly red. (Page 41)..... **aberti**
Legs entirely black.....18
18. Metanotal flange very large, reddish; prothoracic lobe, and usually areas on the pro-, meso-, and meta-pleura, reddish; eyes prominently convergent below. (Page 29)..... **leopardus**
Metanotal flange small or absent; prothoracic lobe and pleura black; eyes slightly convergent below.....19
19. Costa of fore wing at base distinctly amber in reflected light; a very slight metanotal flange. (Page 36)..... **kennedyi**
Costa of fore wing at base black in reflected light; no metanotal flange whatever.....20
20. Wings rather strongly fuliginous; size large. (Page 36)... **urnarius floridensis**
Wings lightly to moderately fuliginous; size medium to small. (Page 30), **urnarius**

Sphex fernaldi n. sp.

(Male genitalia on Plate I.)

Sphex extremitatus Smith. 1908. Univ. Nebr. Studies, vol. 8: 330. (In part.)
Sphex extremitatus Mickel. 1917. Univ. Nebr. Studies, vol. 17: 404. (in part.)
Sphex placidus extremitatus Fernald. 1934. N. Amer. and W. I. digger wasps of the genus *Sphex*, pp. 62–63.

Female.—Length 20 mm. Head: eyes very slightly convergent downward; teeth of clypeus much closer to lower inner margin of eyes than to each other, the proportion being 1—1.66—1; the surface near the lower margin of the clypeus between the teeth descending very abruptly to the rim, thus forming a small lip-like projection; clypeus with scattered large punctures; the surface between the large punctures on the upper half of the slightly bulging central portion of the clypeus almost entirely covered with tiny punctures; the tiny punctures on the lower half of this central portion well separated, the surface appearing quite glossy; the upper edge of the clypeus marked by a suture above the slightly bulging central portion only, the suture fading out on each side of this portion; the frontal suture rather deep from between the antennae to the anterior ocellus; an impression surrounds the ocelli; vertex and frons with bluish sericeous hairs; pilosity of head black. Thorax: collar rather narrow in profile; gutter smooth, narrow but quite deep; scutellum smooth except for fine longitudinal striae along the posterior border and a median longitudinal impression; propodeal disk with ridges running transversely on anterior part, and slanting towards the rear on the posterior part, the surface between the ridges prominently granulated and bearing short black hairs; no pubescent patch beside petiole attachment; propodeal side with weak ridges

which run almost straight downward on posterior part but slant forward on anterior part, the punctures between the ridges not prominent; metapleuron with scattered shallow punctures, the surface between these punctures very finely roughened due to a great many minute shallow punctures and some weak striae; no metanotal flange; episternal suture long; mesopleuron with many moderate-sized punctures and a very large number of tiny punctures, bluish sericeous hairs arising from the tiny punctures, the surface between the punctures rather smooth, not granulate; pilosity of thorax black, though in some lights appearing dark bluish. Wings: rather strongly yellow on basal half, quite fuliginous on apical half. Legs: a slight tooth at base of tarsal claws. Petiole: first and base of second segment black, rest of petiole orange-red. Abdomen: entire first and about half of second segment orange-red, rest of abdomen black with bluish sericeous hairs.

Male.—(Genitalia on Plate I). Length 18 mm. Similar to female except as follows: Head: eyes very strongly converging; clypeus not definitely toothed, but rounded with a broad slight central emargination; punctures on clypeus few, the surface therefore rather glossy; frons with many punctures, both large and small; pilosity very long, black. Thorax: collar more round in profile than in female; scutellum longitudinally ridged on the posterior half; a white pubescent patch on each side of petiole attachment; propodeal side with many weak, broken ridges and medium-sized punctures; metapleuron with many large and small punctures, surface rather glossy, much smoother than in female; mesopleuron similar to metapleuron except that the large punctures are farther apart; sericeous hairs much less numerous than in female and appearing brownish rather than bluish; pilosity of thorax long and black. Wings: moderately fuliginous, not as yellow as in female. Petiole: first and about anterior third of second segment black, rest of petiole reddish-yellow with a black dorsal band. Abdomen: first segment reddish-yellow except at apex dorsally where it is black; rest of abdomen black; some of the sericeous hairs of the abdomen bluish, some brownish, and a few grayish.

Holotype.—Female, Luverne, Minnesota, Sept. 13, 1935 (A. E. Pritchard); *Allotype.*—Male, Lancaster, Minnesota, Aug. 7, 1936 (D. G. Denning); both deposited in the collection of the University of Minnesota.

Paratypes.—Collection of South Dakota State College: SOUTH DAKOTA: Clark, 2 males, July 13, 1926 (M. D. Farrar); White, female, July 22, 1935 (A. G. Peterson). Collection of Iowa Wesleyan College: IOWA: Dickinson Co., female, June 25, 1936 (P. Travis); Lyon Co., 2 males, July 7, 1936 (D. Millspaugh). Collection of University of Minnesota: IOWA: Sioux City, 3 males, female, July 7, 1933, June 17, 22, 1936 (C. N. Ainslie). KANSAS: Riley Co., male, 2 females, May 26, July 23, 25 (Popenoe); female (Marlatt); male, Sept. 30 (J. B. Norton); Wallace, female, July, 1885. MINNESOTA: Detroit,

3 females, Aug. 26, 1924 (O. A. Stevens); Hendricks, female, Sept. 17, 1935 (A. E. Pritchard); Itasca Park, male, 3 females, July 8, 14, 15, 1936; Lake Benton, 2 females, Sept. 12, 1935 (C. E. Mickel); Lancaster, male, 2 females, Aug. 7, 26, 1936 (D. G. Denning); Luverne, 2 females, July 3, 1932, Sept. 13–14, 1935 (C. E. Mickel), female, Sept. 13–14, 1935 (A. E. Pritchard); Kittson Co., female, Aug. 22, 1936 (D. G. Denning); Lincoln Co., male, female, Aug. 13, 1936 (C. E. Mickel); Marshall Co., female, Aug. 4, 1936 (D. G. Denning); Norman Co., 2 males, July 20, 24, 1923 (A. A. Nichol), female, Aug. 31, 1936 (D. G. Denning); Polk Co., 2 males, July 21, 1936 (D. G. Denning); Yellow Medicine Co., 4 males, 7 females, Aug. 13, 1936 (C. E. Mickel). NEBRASKA: Lincoln, female, June. NORTH DAKOTA: Beach, 2 males, 2 females, Aug. 21, Sept. 1, 1921, Aug. 3, 1924 (C. N. Ainslie); Garrison, male, Aug. 17, 1935 (H. S. Telford). SOUTH DAKOTA: Brookings, male, July 6, 1933 (H. C. Severin); Mobridge, male, Aug. 14, 1924 (H. C. Severin). TEXAS: Eastland Co., female, Sept. 30, 1920 (G. O. Wiley).

Variations.—Female: Length 16–21 mm.; occasionally the clypeus is almost uniformly punctured from top to bottom, and not more heavily punctured on the upper half; some specimens have a thin, white, sericeous patch on each side of the petiole attachment; rarely the ridges of the propodeal side curve forward on the anterior part of the plate so that they run almost due forward; the entire second petiolar and the entire second abdominal segments may be reddish. Male: Length 15–20 mm.; the episternal suture is frequently obsolescent or entirely absent from opposite the prothoracic lobe downward; there may be white sericeous hairs scattered sparsely over the pleura.

The type of *Sphex extremitatus* (Cres.) is much like *Sphex placidus* (Sm.), (male genitalia on Plate I), though I believe the two are distinct species. In these two species the ridges of the propodeal side run strongly forward in *both* sexes, and the surface of all the pleura is granulated between the punctures. In *Sphex fernaldi* n. sp. these ridges run only slightly forward or sometimes curve forward on the anterior part only, and the surface of the meso- and meta-pleura is rather glossy between the punctures. *Sphex xanthopterus* (Cam.) is very similar to *Sphex fernaldi* n. sp. but is distinguished by the following characters: size 20–29 mm.; wings only slightly fuliginous on the apical half; teeth of clypeus only slightly closer to the eye than to each other, the proportion being 1—1.25—1; no distinct lip-like projection near the distal margin of clypeus; pilosity of thorax white. The male of *xanthopterus* is unknown.

Females are much more common than males in the species group to which *Sphex fernaldi* n. sp. belongs, therefore the description has stressed the female and a female has been selected for the holotype.

This species is named after Dr. Fernald, who has devoted much of his life to the study of thread-waisted wasps, and who assisted the writer in this work by suggestions and criticisms, and by the loan of type material.

Sphex arvensis (Dahlbom)

(Male genitalia on Plate I.)

Miscus arvensis Dahlbom. 1843. Hym. Eur., vol. 1, p. 8. Male.
Sphex arvensis Fernald. 1934. N. Amer. and W. I. digger wasps of the genus *Sphex*, pp. 62–63. (In part.)

Male.—(Genitalia on Plate I). Length 18 mm. Head: teeth of clypeus blunt, slightly closer to each other than to the eyes, a moderate emargination between them; surface of clypeus with many small punctures; frontal suture evident to anterior ocellus; a distinct depression in front of anterior ocellus; practically no impressions join the ocelli; pilosity of head entirely black. Thorax: collar rising almost vertically from the neck for a short distance, then turning backwards quickly to form an almost flat, rather long, sloping dorsal surface; gutter broad and rather shallow, limited only slightly anteriorly and hardly at all dorsally, with slight ridges in and above it; mesonotum with large punctures which tend to form rows, and ridges frequently run in front of these rows; scutellum with coarse longitudinal ridges and with large punctures between the ridges; a slight pubescent patch on each side of petiole attachment; propodeal side with very numerous large punctures, with ridges in front of most of these punctures; metapleuron with many large punctures but almost no ridges, its surface as well as that of the propodeal side smoothly, finely reticulate; a very weak sericeous band in front of metapleural-propodeal suture; no metanotal flange; episternal suture long; mesopleuron with many large and small punctures; a pubescent band on the mesopleuron extends from the mesocoxal knob to, and slightly on to the back of, the rectangle; surface of the entire pleura with very tiny sericeous hairs; pilosity of prothorax and mesonotum black, of rest of thorax white. Wings: costa at base of fore wing black. Petiole: first segment black, second black with an elongate reddish spot on each side posteriorly. Abdomen: first segment red with a black dorsal band; rest of abdomen dark blue.

Female.—Length 19 mm. Similar to male except as follows: Head: eyes almost parallel; clypeal teeth about as close to lower inner corner of eyes as to each other, the proportion being 1—2—1; a very slight central emargination in the rim of the clypeus; clypeus with many medium-sized punctures and a great many small ones; an impression between the posterior ocelli, but no definite impression between the anterior ocellus and each posterior ocellus. Thorax: a weak sericeous band in front of the meso-meta-pleural suture, rather

than a pubescent one; pilosity of thorax black. Abdomen: entire first segment red, rest of abdomen dark blue.

Described from a male and a female in the collection of the University of Minnesota; male, Cook Co., Minn., July 30, 1936 (C. E. Mickel); female, Ely, Minn., Sept. 7, 1936 (R. H. Daggy).

Holotype.—A male collected in Pennsylvania; it is in Dahlbom's collection at Lund. No allotpye has been erected for this species.

Specimens examined: GEORGIA: Black Rock Mt., Rabun Co., 2 males, May 20–25, 1911; Stone Mt., female, Aug. 3, 1913. MINNESOTA: Ely, female, Sept. 7, 1935 (R. H. Daggy); Lake City, 2 females, July 18, Aug. 8, 1933 (D. J. Pletsch); Redwing, male, July 18, 1935 (A. B. Gurney); Chisago Co., 2 females, July 16, 1918; Cook Co., female, Aug. 1, 1935 (P. M. Schroeder). NEW YORK: Ithaca, male, July 3, 1885 (H. F. Summers), 4 males, female, July 19, 1890, July 9, 1891, July 18, 1900, July 4, 1914, July 25, 1916. PENNSYLVANIA: White Haven, female, Aug., 1902.

Variations.—In similar specimens the ridges of the mesonotum and pleura smooth out, and thus they may be entirely lacking on the mesonotum, propodeal side, and metapleuron. The collar appears to be flatter dorsally in some specimens than in others. Male: Length 16–18 mm.; the depth of the emargination between the teeth of the clypeus may vary from slight to deep, but it is most commonly deep. Female: Length 14–21 mm.; the clypeus is more bulging in some specimens than in others; the larger punctures of the clypeus are considerably larger in some specimens than in others.

The most easily observed characters for separating *arvensis* and *mediatus* are as follows: in *mediatus* there are more or less distinct impressions joining the anterior ocellus to each posterior one; there is almost no depression in front of the anterior ocellus, and this ocellus is not tilted strongly forward; the collar is short and smoothly arching; the gutter is narrow but rather deep, distinctly limited dorsally and anteriorly; the propodeal side and metapleuron have almost no large round punctures, the surface of these plates being entirely very finely transversely striate, and with some stronger ridges. In *arvensis* the impressions joining the anterior ocellus with each posterior one are obsolescent or entirely absent; there is a slight depression in front of the anterior ocellus, and this ocellus is tilted strongly forward; the collar is long and angled in front; the gutter is broad but very shallow, limited only slightly anteriorly and

usually not at all dorsally; the propodeal side has many large round punctures which tend to form rows, with ridges in front of some of these rows; the surface of the propodeal side and metapleuron is smoothly, very finely reticulate.

Sphex dubius Fernald is very similar to *arvensis* (Dahlb.); it has a smooth scutellum, and the pilosity of the cheeks and clypeus are white (only the male is known). *Arvensis* (Dahlb.) and *acutus* Fernald must be closely related; the margin of the clypeus of *acutus* is described as having a small median emargination, outside of which is a smaller one, oblique to the median one (only the male is known); in *arvensis* there is a slight to moderate emargination between the teeth, but none on the outer side of the clypeal margin.

Sphex mediatus (Cresson)

(Male genitalia on Plate I.)

Ammophila mediata Cresson. 1865. Proc. Ent. Soc. Phila., vol. 4, p. 459. Female and male.

Sphex arvensis Fernald. 1934. N. Amer. and W. I. digger wasps of the genus *Sphex*, pp. 118, 120. (In part.)

Male.—(Genitalia on Plate I). Length 18 mm. Head: clypeus not toothed, but narrowly rounded with a slight central emargination; surface of clypeus with many small punctures; frontal suture quite distinct; a poorly marked impression from anterior ocellus to each posterior ocellus, but none between the posterior ocelli; pilosity of head black. Thorax: collar broadly rounded in profile; gutter narrow and rather deep, distinctly limited dorsally and anteriorly, the surface faintly ridged; mesonotum with weak transverse ridges; scutellum longitudinally ridged; sericeous hairs rather numerous on each side of petiole attachment and scattered weakly over propodeal side and metapleuron; propodeal side and metapleuron with almost no large round punctures, the surface of these plates entirely very finely transversely striate, and with some stronger ridges; metanotum with no flange whatever; episternal suture long; sericeous hairs thinly cover the entire mesopleuron, but they are slightly more numerous in front of the meso- meta-thoracic suture; pilosity of prothorax and mesonotum black, of rest of thorax white. Wings: costa at base of fore wing black. Petiole: first and about one-third of second segment black, rest of petiole red. Abdomen: first segment red, rest of abdomen black with dark bluish tinge.

Female.—Length 18 mm. Similar to male except as follows: Eyes almost parallel; teeth of clypeus closer to lower inner corner of eyes than to each other, the proportion being 1—1.6—1; clypeal margin with no central emargination; clypeus without many large punctures, but with principally moderate-sized and small punctures; there is a fine reticulation between the small punctures which reduces the gloss

of the surface; there is a weak impression between the posterior ocelli; pilosity of head black. Thorax: gutter with several prominent ridges; pilosity of prothorax and mesonotum black, of rest of thorax brownish.

Described from a male and a female which have been compared with holotype. Male, Itasca Park, Minn., May 29, 1934 (C. Y. Liu); female, Lake Co., Minn., June 20, 1936 (R. H. Daggy); both are in the collection of Minnesota University.

Holotype.—Female, Colorado. In collection of American Entomological Society, Philadelphia. *Ammophila mediata* was described by Cresson from six females and three males. One female was selected as holotype; the males may be considered as an allotype series, as no individual has been selected as allotype.

Specimens examined: ALBERTA: Waterton, male, July 13, 1923 (E. H. Strickland), male, July 1, 1923 (Walter Carter), female, July 11, 1923 (H. L. Seamans). BRITISH COLUMBIA: Carbonate, Columbia River, 2 males, July 7–12, 1908 (J. C. Bradley); Coldstream, female; Fernie, male, June 14, 1934 (Hugh B. Leech); Field, Rocky Mts., 2 males, July 1, 1908 (J. C. Bradley); Revelstoke, 4 males, July 4–6, 8–13, 1905 (J. C. Bradley); male, July. COLORADO: female, Aug. 14, 1934 (A. E. Pritchard). MINNESOTA: Itasca Park, male, June 2, 1931 (L. W. Orr), 5 females, June 29, July 28, 1914, July 12, 19, 1936; Cass Co., 3 females (O. W. Oestlund); Cook Co., male, Aug. 2, 1928 (L. W. Orr), 2 females, Aug. 9, 17, 1935 (P. M. Schroeder); Lake Co., 2 males, female, June 20, 1936 (R. H. Daggy); Ramsey Co., male, Sept. 7, 1935 (P. M. Schroeder); male.

Variations.—The abdomen posterior to the red part may be distinctly blue. Male: Length 14–16 mm.; the edge of the clypeus may be somewhat reflexed; the frontal suture may fade out before reaching the anterior ocellus; on the thorax there is no sharp or constant line where white hairs change to black hairs, the entire thorax may have white pilosity, or the pilosity may be brownish or black over most of the thorax; the second segment of the petiole varies from entirely red to entirely black or piceous; about one-half of the second abdominal segment may be red. Female: Length 16–21 mm.; the propodeal side has complete ridges in some specimens.

Sphex arvensis (Dahlb.) and *Sphex mediatus* (Cress.) resemble each other in many ways; they are easily separated by the shape of the collar, which in *mediatus* is short and smoothly arching, and in *arvensis* is long and angled in front. For other distinctions see *arvensis*.

Sphex pilosus Fernald

(Male genitalia on Plate I.)

Sphex pilosus Fernald. 1934. N. Amer. and W. I. digger wasps of the genus *Sphex*, pp. 120–121. Female, Male.
Sphex aculeatus Fernald. 1934. N. Amer. and W. I. digger wasps of the genus *Sphex*, pp. 145–147. Female, Male.

Male.—(Genitalia on Plate I). Length 17 mm. Head: "teeth" of clypeus rounded, the emargination between them moderate; pilosity of head white. Thorax: gutter deep and with several weak ridges; mesonotum with some slight ridges on lateral part; scutellum not smooth, but with some longitudinal ridges and rather large punctures; propodeal disk with rather strong ridges which slant slightly backwards; large pubescent patch on each side of petiole attachment; propodeal side with many large punctures which tend to form rows, with slight ridges in front of a few of the rows; large punctures on metapleuron more separated than on propodeal side; surface of both plates with many minute punctures from which arise fine white sericeous to pubescent hairs; metanotal flange large; surface of mesopleuron much like that of metapleuron; in front of meso-meta-pleural suture is a heavy pubescent band which grades into sericeous hairs which cover the entire mesopleuron; pilosity of thorax white. Wings: costa of front wing at base black or piceous. Petiole: first segment black; second red with a black dorsal stripe. Abdomen: first segment entirely red; second red on anterior half except for a black dorsal stripe, entirely black on posterior half; rest of abdomen black.

Female.—Length 20 mm. Similar to male except as follows: Head: eyes slightly convergent downward; teeth of clypeus slightly closer to the lower inner corner of the eye than to each other, the proportions being 1—1.25—1; clypeus slightly bulging centrally, with many large and small punctures; pilosity of head white, with a few slightly darker hairs on clypeus, mandibles and cheeks. Thorax: collar rather narrow in profile; ridges more prominent on metathorax and propodeal side than in male; pilosity of thorax white. Petiole: first and base of second segment black, rest of petiole red. Abdomen: first segment red except for a black dorsal spot posteriorly; second red with a black dorsal stripe; rest of abdomen black.

Described from a male and a female which have been compared with the holotype and allotype of both *Sphex pilosus* Fernald and *Sphex aculeatus* Fernald. Male, Mt. Charleston, Nevada, Aug. 13, 1931 (E. R. Tinkham); female, Sargents Bluff, Iowa, July 14, 1930 (C. E. Mickel); both are in the collection of Minnesota University.

Holotype.—Female. *Allotype.*—Male, Colorado. Both are in the collection of American Entomological Society, Philadelphia.

Sphex aculeatus was described by Fernald from a mated pair collected at Boulder Co., Colorado, Sept. 15, 1932, by Prof. Chas. H. Hicks. I have studied a large series of specimens and

am convinced that *aculeatus* is synonomous with *pilosus*. A study of the male genitalia has added further proof to this conclusion. The holotype and allotype of *S. aculeatus* are identical with the holotype and allotype of *S. pilosus* in all the characters which I consider to be significant.

Specimens examined: ALBERTA: Bow Island, male, June 31, 1923 (H. E. Gray); Delia, female, July 22, 1935 (E. H. Strickland). CALIFORNIA: Cedarville, 2 females, July 3, 1935 (Joe Schuh); Togo Pass, female, Aug. 2, 1930 (E. R. Tinkham); Truckee, 2 males, 2 females, July 5, 1936 (A. E. Pritchard). COLORADO: Colorado Springs, female, Aug. 15, 1934 (A. E. Pritchard); El Paso Co., Mt. Manitou, male, July 1, 1921 (G. O. Wiley); Manitou, male, Aug., 1885; Salida, female. IOWA: Sioux City, 3 males, 4 females, Aug. 26, 27, 1920, July 8, 1921, Aug. 17, 1933, Sept. 7, 1936 (C. N. Ainslie). NEBRASKA: Omaha, male, female, July 2, 1913 (L. T. Williams). NEVADA: Mt. Charleston, female, Aug. 14, 1931 (E. R. Tinkham). NEW MEXICO: Raton, female, Aug. 16, 1934 (A. E. Pritchard). NORTH DAKOTA: Dickinson, female (C. N. Ainslie). OREGON: Blitzen Valley, 2 males, July 14, 1936 (S. Jewett); Cornucopia, male, July 25, 1936 (H. A. Scullen); Grant Co., Fall Mt. Lookout Tr., female, July 14, 1936 (H. A. Scullen). UTAH: Cache Jc., female (E. G. Titus); College Ward, female, July 20, 1934 (W. L. Thomas); Collinston, female, Sept. 15, 1930 (G. F. Knowlton); Curlew, female, Aug. 30, 1929 (G. F. Knowlton); Emory Co., 2 males, female, Sept. 3, 15, 1921 (G. O. Wiley); Eureka, female, June 12, 1910; Flux, female, Aug. 31, 1932 (G. F. Knowlton); Ft. Duchesne, 5 females, July 14, 16, 29, 1932 (F. K. Stoffers), female, Aug. 6, 1932 (Lowell Cutler); Lempe, female, July 17, 1931 (G. F. Knowlton); Granite, female, June 10, 1936 (W. M. Allen); Logan, female, Sept. 14, 1929 (G. F. Knowlton), female, Sept. 30, 1932 (J. H. Linford), female, Sept. 17, 1931; Logan Canyon, female (H. R. Hogan); Portage, female, Aug. 20, 1923 (G. F. Knowlton); Sardine Canyon, 2 females, Aug. 9, 1933 (G. F. Knowlton); Smelter, female, July 18, 1909 (E. G. Titus); Snowville, female, Aug. 22, 1929 (G. F. Knowlton); Timpie, female, June 27, 1932 (G. F. Knowlton).

Variations.—The development of the sericeous or pubescent hairs on the pleura varies greatly. When the pleura are nearly bare except for a more or less prominent pubescent band in front of the meso-meta-pleural suture, the individual belongs to the subspecies *nudus*. Ridges are not always present on the gutter. The large punctures of the

propodeal side frequently have prominent ridges in front of them. The metanotal flange is occasionally small, and very rarely it is entirely absent. Male: Length 13–18 mm.; the second petiolar segment may be entirely red; the first abdominal segment may be entirely red and the rest of the abdominal segments black; the first segment may have a black dorsal band; the entire first and second segments and part of the third or even fourth segments may be red. Female: Length 17–22 mm.; the middle of the clypeal rim is sometimes quite emarginate; the second abdominal segment may be black except for a red area on each side; the first, second, all but a black posterior dorsal spot of the third, and sides of the fourth segments may be red, the rest of the abdomen black.

Heavily pubescent specimens of this species resemble *Sphex harti* Fernald very closely. However, the costa at the base of the front wing is black or reddish-black in *pilosus* and light yellow in *harti*.

Sphex pilosus subsp. **nudus** n. subsp.

Sphex arvensis Fernald. 1934. N. Amer. and W. I. digger wasps of the genus *Sphex*, pp. 118–120. (In part.)

This subspecies differs from subsp. *pilosus* only in the expression of the sericeous hairs as influenced apparently by the environment. The pleura bear minute punctures exactly as in *pilosus*, but the sericeous hairs arising from them are short and quite inconspicuous. There is a weak pubescent band in front of the meso-meta-pleural suture. Specimens of this subspecies which have the metanotal flange imperfectly developed, as sometimes occurs, appear so different from *pilosus pilosus* that the two subspecies might easily be considered as two distinct species by one who had not seen the intermediate forms or who had not studied the male genitalia. Due to the quite different appearances of the extremes, it was considered desirable to erect this new subspecies.

Holotype.—Male, Sawyer, Minn., July 2, 1935 (D. G. Denning); *Allotype.*—Female, Middle River, Minn., July 25, 1935 (D. G. Denning).

Paratypes.—Collection of Oklahoma Agricultural College: COLORADO: Pingree Park, 2 males, 4 females, Aug. 14, 1934 (A. E. Pritchard). Collection of Oregon Agricultural College: OREGON: Baker Co., female, July 27, 1936 (H. A. Scullen); Cornucopia, male, July 24, 1936 (H. A. Scullen), male, July 25, 1936 (R. E. Rieder); Grant Co., 2 males, 2 females, July 21, 1936 (H. A. Scullen). Collection of University of Minnesota: ALBERTA: L. Newell, June 9, 1923 (Walter Carter). COLORADO: Male (B. S. Kimball). MINNESOTA: Brainerd, male, July 2, 1934 (D. J. Pletsch); Itasca Park, 4 males, 3 females, July, 1908, June, 1911, July 23, 1912, June 19, 23, July 21, 1914, male, 2 females, July 19, 1935 (A. C. Hodson), male, June 16, 1936

(C. E. Mickel); Lancaster, female, Aug. 26, 1936 (D. G. Denning); Luverne, female, Sept. 10, 1913; Middle River, 3 females, July 25, Aug. 10, 1935 (D. G. Denning); Sawyer, 2 males, July 2, 1935 (D. G. Denning); St. Paul, female, June 16, 1922 (A. T. Hertig); Cass Co., 5 males, 3 females (O. W. Oestlund); Chisago Co., female (O. W. Oestlund); Kittson Co., male, Aug. 28, 1936 (D. G. Denning); Koochiching Co., female, Aug. 16, 1910, female (O. W. Oestlund); Polk Co., male, 3 females, Aug. 16, 1924 (Walter Carter). NORTH DAKOTA: Trail Co., female, July 9, 1923 (A. A. Nichol).

The following are specimens which are *intergrades* between the subspecies *pilosus* and *nudus;* all are in the University of Minnesota collection. ALBERTA: Jasper, female, Aug. 15, 1932 (Hugh Leech); Barnwell, female, July 26, 1935 (R. W. Salt). NORTH DAKOTA: Beach, male, Sept. 1, 1921 (C. N. Ainslie). COLORADO: 2 females, July (B. S. Kimball). MINNESOTA: Clear River, female, July 17, 1925 (C. B. Phillip); Sawyer, male, July 2, 1935 (D. G. Denning). WYOMING: Moran, female, July 29, 1921 (F. M. Sallee).

Sphex leopardus Fernald

(Male genitalia on Plate I.)

Sphex urnarius leopardus Fernald. 1934. N. Amer. and W. I. digger wasps of the genus *Sphex.*, pp. 125–126. Female, Male.

Male.—(Genitalia on Plate I). Length 18 mm. Head: clypeus with two rounded lobes, there being a slight emargination in the middle of the clypeus; surface of clypeus with many large punctures and a great many small punctures between the large ones; frontal suture indistinct; surface in front of anterior ocellus glossy; a slight impression between anterior ocellus and each posterior ocellus, none between the posterior ocelli; pilosity of head white. Thorax: collar broadly rounded in profile; gutter very shallow; scutellum with many large punctures, not logitudinally ridged; ridges of propodeal disk longitudinal except posteriorly where they curve slightly toward the side; propodeal side with many coarse punctures which run together; metapleuron with many large punctures with less tendency to run together; surface of both metapleuron and propodeal side lightly sericeous, a prominent band along metapleural-propodeal suture; metanotal flange extremely large, with a prominent emargination, and reddish in color; episternal suture short, deep; a pubescent band in front of meso-meta-pleural suture from mesocoxal knob to top of rectangle, running along the posterior half of the rectangle; mesopleuron with sericeous hairs; prothoracic lobe red; pilosity of thorax white. Petiole: first segment black, curved slightly upwards towards the apex; second segment reddish black. Abdomen: first segment red with a black apical band, rest of abdomen black.

Female.—Length 18 mm. Similar to male except as follows: Head: eyes prominently convergent below; rim of clypeus expanded on each side about half way between the eye and the center, but not forming a distinct tooth; clypeus with a great many large and small punctures; frontal suture distinct to within a short distance of anterior ocellus; ocelli not joined by any impression; pilosity of head white. Thorax: scutellum longitudinally ridged with large punctures between the ridges; reddish areas of thorax more extensive than in male, including prothoracic lobe and gutter, in front of meso-meta-pleural suture, and posterior part of metapleuron; pilosity of thorax white. Petiole: first segment black, second black at base only; rest of petiole red. Abdomen: first segment red, rest of abdomen black.

Described from a male and a female located in the collection of Minnesota University; male, female, Washington Co., Minn., July 11, 1936 (D. Murray); the male compared with the allotype and the female with the paratype in the collection of the American Entomological Society at Philadelphia.

Holotype: a female, collected in Georgia, now located in the United States National Museum; *allotype:* a male, collected in Georgia, now located in the collection of the American Entomological Society; *paratypes:* one female in the collection of the American Entomological Society, two females in the Cornell University collection, and one male in the collection of Dr. H. T. Fernald.

Specimens studied: MINNESOTA: Barden, male, Aug. 25, 1922 (C. E. Mickel); Ft. Snelling, female, Aug. 13, 1924 (R. W. Dawson); Washington Co., 4 males, 3 females, July 11, 19, 1936 (D. Murray). OHIO: Clyde, 2 females, Aug. 4, 1912.

Variations.—The extent of red on the thorax may vary in both sexes, but at least some red is always present. Male: Length 16–18 mm.; the scutellum may be longitudinally ridged. Female: Length 16–20 mm.

The male genitalia, the large metanotal flange, the shape of the clypeus in both sexes, and other characters leave no doubt but that this is a distinct species.

Sphex urnarius (Dahlbom)

(Male genitalia on Plate I.)

Ammophila urnaria Dahlbom. 1843. Hym. Eur., Vol. 1, p. 14. Male.
Ammophila inepta Cresson. 1872. Trans. Amer. Ent. Soc., vol. 4, p. 209. Female, Male.

Male.—(Genitalia on Plate I). Length 18 mm. Head: clypeus toothed, strongly emarginate between the teeth; surface of clypeus with the large punctures conspicuous though rather scattered, and with a great many small punctures; sericeous hairs sparse on middle, more

numerous on sides, of clypeus; frons with scattered large punctures, and with numerous minute punctures which give rise to very tiny hairs; a prominent impression extends around the ocelli; pilosity of head white. Thorax: collar broadly rounded in profile, forming almost a part of a circle; gutter small but moderately deep, without ridges; mesonotum with some transverse ridges above, especially between the wings; scutellum longitudinally ridged, with large punctures between the ridges; propodeal disk with rather strong transverse ridges which slant considerably towards the rear on the anterior part, slightly towards the rear on the posterior part; a very small pubescent patch on each side of petiole attachment; propodeal side with very many large punctures which tend to form rows, many of these punctures having a short ridge in front of each of them; sometimes these ridges extend in front of several punctures in a row; there is a trace of sericeous hairs along the metapleural-propodeal suture; metapleuron with large punctures not quite as numerous as on propodeal side, with many tiny punctures, the surface of the plate glossy; no metanotal flange whatever; episternal suture short; a strong ridge rising abruptly anterior to the episternal suture and extending to the bottom of the rectangle; the lower side of the rectangle marked anteriorly by a deep depression; a pubescent band in front of meso-meta-pleural suture extending from mesocoxal knob to, and slightly on to the back of, the rectangle, not diffusing much over the mesopleuron; pilosity of thorax white. Wings: moderately fuliginous, costa near base of fore wing black or reddish black (this must be seen in light reflected from the costa and not in light transmitted through it). Petiole: both segments black. Abdomen: first segment red on sides, with a black dorsal stripe and a black apical band; rest of abdomen black with a slight bluish tint. Male genitalia: outer claspers very broad.

Female.—Length 20 mm. Similar to male except as follows: Head: the eyes converging very slightly below the antennae; each tooth of clypeus about as close to the middle of the clypeal border as to its respective eye, the proportion being about 1—2—1; clypeal border with a slight central emargination; clypeus with large punctures well scattered, with many small punctures between the large ones; pilosity of head white, except for a few dark hairs on sides of clypeus, cheeks, and mandibles. Thorax: collar not as rounded in profile as in the male; definite, though not strong, ridges on the propodeal side and metapleuron; pubescent stripe on mesopleuron and pubescence on prothoracic lobe golden; pilosity of thorax white. Petiole: apex of second segment red, rest of petiole black. Abdomen: first segment red with a thin black apical band, rest of abdomen dark bluish-black.

Described from a male and a female in the University of Minnesota collection; male, female, Sawyer Co., Wisconsin, Aug. 3–8, 1936 (Don Murray).

Holotype.—A male collected in South Carolina; it is in Dahlbom's collection at Lund. I have not seen the type, and cannot be absolutely certain that it is this species rather than

the species I have named *kennedyi*. Since *urnarius* is more eastern in distribution and *kennedyi* more western, and since I have seen only a few specimens of *kennedyi* from southeastern United States, while I have seen a great many specimens of *urnarius* from this region, it is highly probable that the type is as I have interpreted it to be. If in the future it is found that the type of *urnarius* is the species I have called *kennedyi*, then Cresson's *inepta* would supplant what I have called *urnarius*. *Inepta* was described by Cresson from five male and female specimens collected in Texas. The female type and two paratypes are in the collection of the American Entomological Society at Philadelphia.

Specimens examined: CANADA: Montreal, female, June 18, 2 females (G. Chapman); Montreal Island, female, Aug. 10, 1901; St. Hilaire, male, July 11, 1902; Val Morin, 2 males, female (C. J. Quellet). CONNECTICUT: Lyme, male, May 29, 1910 (A. B. Champlain). FLORIDA: Sarasota, male, Aug. 14, 1910 (J. C. Bradley). GEORGIA: Albany, female, Sept. 1, 1910; Atlanta, 2 males, June 30, July 6, 1909; Austell, male, Aug. 27, 1910; Bainbridge, female, Sept. 17–Oct. 19, 1910 (J. C. Bradley); Billy's Island, Okefenokee Swamp, male, June, 1912; Burton, male, female, May 21, 1911 (J. C. Bradley); Clarksville, 2 males, Aug. 10, 1909; Clayton, male, May 18–26, 1911 (J. C. Bradley), male, Aug. 18; DeWitt, male, July 23, 1912 (M. D. Leonard), 2 males, Aug. 1, 1912; Lavender, Floyd Co., male, Aug. 23, 1910 (J. C. Bradley); Marietta, 3 males, June 7, 1909; Pomona, female, June 4, 1907; Rabun Bald, female, Aug. 21, 1913; St. Simon's Isle, male, Sept. 9, 1909; Spring Creek, 2 males, May 18–21, 1916, June 7–23, 1911 (J. C. Bradley), male, July 16–29, 1912; Summerville, 2 males, Aug. 22, 1910 (J. C. Bradley); Tallulah Falls, 7 males, female, June 19, 1925 (J. C. Bradley); Toccoa, male, Aug. 18, male; Unadilla, 3 males, June 25, 1910 (J. C. Bradley). ILLINOIS: Chicago, male, 1899; Moline, male, female (O. W. Oestlund). INDIANA: Brown Co., female, July 12, 1914 (H. F. Dietz); Harrison Co., 2 females, July 21, 1911 (Coll. State Ent.); Marion Co., male, June 30, 1911 (Harold Morrison). IOWA: Belle Plaine, male, July 3, 1936 (D. J. Pletsch); Mt. Pleasant, female, June 6, 1929 (Bruhn); Sioux City, 4 males, 2 females, Sept. 8, 1920, July 7, Aug. 17, 1922, Aug. 6, 1930, July 21, 1931, Aug. 31, 1934 (C. N. Ainslie); Dickinson Co., 3 males, 2 females, June 19, July 3, 6, 1936 (D. Millspaugh), 2 males, female, June 18, July 6, 1936 (H. E. Jaques), 3 males,

July 6, 1936 (Mabel Jaques); Freemont Co., female, Aug. 12, 1936 (H. E. Jaques); Harrison Co., female, Aug. 11, 1936 (H. E. Jaques); Henry Co., male, 2 females, July 25, 1936 (D. Millspaugh); Lyon Co., 2 males, female, July 7, 1936 (D. Millspaugh); Mitchell Co., 2 males, June 29, July 3, 1936 (D. Millspaugh); Monona Co., male, Aug. 11, 1936 (H. E. Jaques); Muscatine Co., female, June 14, 1936 (B. Berger); Sioux Co., female, Aug. 10, 1936 (H. E. Jaques). KANSAS: Riley Co., male, July 15 (Kimball), male, July 24, (J. B. Norton), male, Aug. 3 (G. A. Dean), 2 females, Aug., Oct. (Marlatt). MARYLAND: Prince George Co., male, female, Aug. 23, 1929 (C. E. Mickel). MICHIGAN: Douglass Lake, female, Aug. 23; Mullet Lake, 3 males, 4 females, Aug. 9, 10, 15, 1935 (W. D. Murray). MINNESOTA: Albert Lea, 2 males, Aug. 5, 1924 (C. B. Philip); Badger, female, July 18, 1935 (D. G. Denning); Eitzen, female, Aug. 24, 1935 (C. E. Mickel); Excelsior, male, Aug. 1, 1933 (Hodson & Oosthuizen); Faribault, 2 females, July 29, 1921 (J. D. Winter); Florian, 2 males, Aug. 9, 1935 (D. G. Denning); Garden City, male, Sept. 15, 1935 (C. E. Mickel); Hay Creek, female, June 29, 1935 (R. H. Daggy); Highwood, female, July 23, 1918 (Wm. A. Riley); Itasca Park, 10 males, July 2, 7, 15, 21, 1914, July 12, 14, 15, 18, 1936, 2 males, July 15–30, 1935 (A. C. Hodson), male, Aug. 22, 1913, female, June 25, 1936, 2 females, July 4, 12, 1936, female, July 19, 1935 (A. C. Hodson), female, Aug. 3, 1924; La Crescent, female, July 12, 1922 (C. E. Mickel); Lake City, female, July 7, 1921 (A. A. Nichol), female, Sept. 17, 1935 (A. B. Gurney); Lake Minnetonka, 2 males, June 26, 1931, June 14, 1932 (D. G. Denning), 2 males, June 25, 1932 (H. H. Shepard), female, Sept. 11, 1923 (H. H. Knight); Lansboro, female, Sept. 15, 1913; Laporte, male, Aug. 25, 1930 (D. G. Denning); LeSueur Center, male, 2 females, June 9, 1922 (C. E. Mickel); Luverne, 2 females, Sept. 10, 1913; Middle River, 2 males. Aug. 9, 1935 (D. G. Denning); Minneapolis, 3 females, June 27, 1921 (A. A. Nichol); Newport, male, July 26, 1930 (C. E. Mickel), 2 males, July 26, 1930 (W. D. Buchanan); Owatonna, 3 males, June 22, 1922 (W. E. Hoffman); Redwing, male, female, July 18, 24, 1935 (A. B. Gurney); Rochester, male, June 14, 1922 (C. E. Mickel); St. Paul, male, June 15, 1912, male, June 12, 1921 (H. H. Knight), 2 males, 2 females, Sept. 5, 6, 14, 1924 (Walter Carter), 3 males, May 20, Aug. 22, 1922 (Arthur Hertig), 2 males, female, Aug. 12, 1924, Sept. 19, 1925 (R. W. Dawson), 2 males, July 1, 14, 1936 (Don Murray), female,

Sept. 12, 1912, female, Sept. 19, 1924 (Sam Kepperly); Willow River, male, Aug. 7, 1922 (W. E. Hoffman); Willmar, male, Aug. 2, 1935 (D. G. Denning); Anoka Co., 3 males, female, Aug. 11, 1924, June 19, 1925 (C. B. Philip), male, 3 females, Aug. 11, 15, 1924 (R. W. Dawson); Becker Co., female, Aug. 12, 1935 (C. E. Mickel); Beltrami Co., female, Aug. 5, 1910; Carver Co., male, Aug. 22, 1929 (E. C. Alfonsus); Cass Co., 3 males (O. W. Oestlund), female, July 26, 1936 (D. G. Denning); Chisago Co., 3 males, female, July 15, 16, 1911; Faribault Co., female, Aug. 18, 1936 (C. E. Mickel); Hennepin Co., male, Aug., 1936 (J. E. Hill), female, Aug. 14, 1930 (H. D. Berman); Kittson Co., male, June 19, 1936 (D. G. Denning); Norman Co., 2 males, 4 females, June 20, 1922, July 1, 17, Aug. 8, 1923, June 30, 1936 (A. A. Nichol); Olmsted Co., 2 males, female (C. N. Ainslie); Polk Co., male, Aug. 16, 1924 (Walter Carter); Ramsey Co., male, 2 females, Aug. 18, 30, 1931, June 29, 1922 (A. T. Hertig), male, July 17, 1932 (N. C. Sullivan), male, Oct. 1, 1935 (Stanley Mickel), female, Aug. 9, 1924, female, Sept. 7, 1935 (P. M. Schroeder), female, Aug. 18, 1936 (D. J. Pletsch); Steele Co., 3 males, July 29, 1936 (S. S. Easter); Todd Co., 2 males, Aug. 14, 1936 (Don Murray); Washington Co., male, July 21, 1911, male, July 19, 1936 (Don Murray); Winona Co., male, June 30, 1922 (H. H. Knight); male. MISSISSIPPI: Agr. Col., male, May 18, 1921 (C. E. Russell). MISSOURI: Springfield, 2 males, female, July 30, 1912 (H. H. Knight). MONTANA: Forsyth, male (C. N. Ainslie). NEBRASKA; Cedar Bluffs, female, Sept. 27, 1913 (G. W. Deming); Omaha, male, Aug. 16, 1913 (L. T. Williams). NEW JERSEY: Atco, male (J. C. Bradley); Bloomfield, male, June 4, 1936 (J. N. Nichols); Clementon, male, May 24, 1902 (J. C. Bradley); Palisades, 3 males, female, Sept. 1, 1916. NEW YORK: Black Brook, male, June 21, 1915; Caroline-Harford, male, June 15, 1904; Clifton Springs, female, Sept. 1, 1890; Ithaca, 13 males, 10 females, July 16, 1886, June 20, 1890, July 6, Aug. 19, July 9, 1891, Aug. 15, 1893, July 27, 1896, Aug. 18, 20, 1898, June 13, 1906, July 27, Aug. 3, 4, 7, 18, 1916, July 30, 1921, 12 males, 5 females, July 26, Aug. 7, 10, 14, 17, 1931, July 2, 12, 16, 1935 (P. P. Babiy), female, July 28, 1885 (F. V. Coville); Middletown, male, July 2–20, 1910 (Ch. Spooner); Mt. Whiteface, female, Aug. 22–24, 1916; New Russia, 4 females, Aug. 18, 1912 (J. C. Bradley); Otto, female (Comstock); Riverhead, Long Island, female, Sept. 10, 1913; Taughanic Falls, 2 males, 2 females, July 4, 1914,

Aug. 17, 1923, Aug. 15, 17, 1925; Wilmington, male, Aug. 20–25, 1916. NORTH CAROLINA: Raleigh, male, Aug., 1923 (J. E. Eckert); West Raleigh, male, Sept. 6, 1917. NORTH DAKOTA: Trail Co., female, July 19, 1923 (A. A. Nichol). OHIO: Columbus, male, June, 1931 (Don Murray); Logan Co., male, Aug., 1930 (Don Murray); Salinville, male. OKLAHOMA: Broken Bow, male, female, June 17, 1934 (J. Stankavich), male, June 19, 1934 (A. E. Pritchard); Flint, 2 males, June 14, 26, 1934 (A. E. Pritchard), June 26, 1934 (J. Stankavich); Grove, June 27, 1934 (A. E. Pritchard); Hugo, June 20, 1934 (J. Stankavich); Page, 2 males, 4 females, June 24, 1934 (J. Stankavich), male, June 24, 1934 (A. E. Pritchard); Sallisaw, male, June 24, 1934 (J. Stankavich), 2 females, June 24, 1934 (A. E. Pritchard); Wyandotte, male, June 4, 1934 (J. Stankavich), male, June 4, 1934 (A. E. Pritchard); LeFlore Co., July 31, 1931 (Costner & Davis); Oklahoma Co., male, female, Oct. 18, 1930 (E. Hixson); Osage Co., July 30, 1932 (W. D. Davis); Pawnee Co., female, July 12, 1932 (A. E. Pritchard), female, July 19, 1932 (C. C. Deonier); Payne Co., female, June 21, 1928 (G. B. King). PENNSYLVANIA: Adela, male, Sept. 2, 1902 (J. C. Bradley); Fairview, male, Aug. 18; Philadelphia, male, Aug., 1911 (Carl Ilg); Roberts, male, female (J. C. Bradley); White Haven, female (J. C. Bradley); Pike Co., male, female, July, 1902 (J. C. Bradley). TENNESSEE: Memphis, 14 males, July 16, 1914 (J. C. Bradley). VIRGINIA: male, June 19, 1881; Arlington Co., female, July 20, 1929 (C. E. Mickel). WISCONSIN: Sawyer Co., 2 males, 2 females, Aug. 3–8, 1936 (Don Murray).

Variations.—Rarely there are only a few or even no large clypeal punctures; some specimens have a slight metanotal flange; the costa near the base of the fore wing is occasionally brownish; rarely the transverse ridges on the mesonotum between the wings are weakly developed or even absent; the ridge anterior to the episternal suture is often not strong, occasionally as weak as in *kennedyi*; the metapleuron and propodeal side sometimes have no ridge whatever; in more southern specimens the entire pleura are frequently slightly sericeous, with a prominent pubescent band in front of the meso-meta-pleural suture and a weak band along the metapleural-propodeal suture; the pubescent band on the mesopleuron may diffuse over the rectangle and over some of the pleuron below the rectangle. Male: length 13–22 mm.; clypeus is occasionally slightly emarginate between the teeth; the clypeus is smoother and shinier in some specimens than in others due to the smaller punctures being smaller and more scattered than usual and to the absence of the usual minute surface reticulation; the second petiolar segment sometimes has some red on the sides or at the apex;

the black stripe on the second abdominal segment is occasionally obsolescent anteriorly or posteriorly and very rarely it is entirely absent. Female: length 15–22 mm.; the large punctures of the clypeus are frequently in large sunken areas; one female which had been strepsipterized has a black dorsal band on the first abdominal segment.

This is an extremely variable species, and the only characters which absolutely define it are found in the male genitalia. No other characters have been found which will hold in every case. The outer claspers of the genitalia protrude sufficiently in every male of this species I have seen to enable me to separate at a glance the males of *urnarius* from the males of *kennedyi*. Following the description of *kennedyi* is a list of the most helpful characters for distinguishing *urnarius* from *kennedyi*.

Juncius (Cresson) is very closely related to *urnarius*. The male genitalia are so similar that a careful study is necessary in order to distinguish them. In every specimen of *juncius* I have seen the pubescent band along the metapleural-propodeal suture is much more strongly developed than in *urnarius*.

Sphex urnarius subsp. **floridensis** Fernald

Sphex floridensis Fernald. 1934. N. Amer. and W. I. digger wasps of the genus *Sphex*, pp. 126–128.

This subspecies differs from *urnarius* (Dahlb.) only in size and in the degree of fuliginous of the wings. The male genitalia are exactly identical with the genitalia of *urnarius*. The larger size of *floridensis* must be due at least in part to parasitizing a larger catepillar. The darker color of the wings is probably due to the environmental conditions under which development takes place.

Holotype.—Female, Orlando, Florida, June 14, 1931 (H. T. Fernald). *Allotype*.—Male, Orlando, Florida, April 22, 1931 (H. T. Fernald). I have studied both holotype and allotype including the male genitalia of the allotype. The male and female paratypes in the Collection of the American Entomological Society at Philadelphia were also examined.

Sphex kennedyi new name

(Male genitalia on Plate I.)

Ammophila vulgaris Cresson. 1865. Proc. Ent. Soc. Phila., vol. 4: 458. Female. (Nom. preocc. Kirby, 1798, Trans. Linn. Soc. Lond., vol. 4, p. 202.)

Male.—(Genitalia on Plate I). Length 18 mm. Head: clypeus toothed, strongly emarginate between the teeth (indistinguishable from *urnarius*); small punctures on surface of clypeus numerous, but smaller in size than is usual in *urnarius;* pubescent hairs on clypeus more

abundant than is usual in *urnarius;* fine sericeous hairs present over entire frons and vertex; frontal suture evident to within a short distance of anterior ocellus, where it fades into a glossy area; an impression extends around the ocelli, but between the posterior ocelli it is rather weak; pilosity of head white. Thorax: collar broadly rounded in profile; gutter small but deep, without ridges; mesonotum without transverse ridges; scutellum longitudinally ridged; transverse ridges of propodeal disk slanting backwards on anterior part, and running almost transversely on posterior part; a small pubescent patch on each side of petiole attachment; propodeal side and metapleuron almost identical in character, with large punctures and a great many minute punctures, no ridges in front of the large punctures; sericeous and pubescent hairs arising from the minute punctures cover thinly the two plates, but they are more abundant along the metapleural propodeal suture; metanotum with a very slight flange, distinguishable from the usual condition in *urnarius;* episternal suture very short, not separating the lower half of the rectangle from the prepectus; lower edge of rectangle scarcely marked; a pubescent band in front of meso-meta-pleural suture extending from mesocoxal knob to the top of the rectangle, diffusing over the rectangle and to some extent over the entire mesopleuron; pilosity of thorax white. Wings: costa at base of front wing distinctly amber in color. Petiole: first and about one-third of second segments black, rest of petiole red with a dark red dorsal stripe. Abdomen: first segment entirely red; rest of abdomen black, no bluish tint whatever. Male genitalia: outer claspers quite thin.

Female.—Length 21 mm. Similar to male except as follows: Head: eyes converging very slightly below the antennae; each tooth of clypeus very slightly closer to the lower inner corner of the eye than to the middle of the clypeal border, the proportion being 1—2.25—1; the clypeal border has a central emargination; clypeus with scattered medium-sized punctures and a very great many small punctures between the large ones; clypeus bulging slightly in the center; frontal suture distinct to anterior ocellus; a distinct impression extends around the ocelli; pilosity of head white, except for a few darker hairs on sides of clypeus, cheeks, and mandibles. Thorax: collar not as rounded in profile as in male; a few of the punctures on propodeal side and metapleuron tend to form rows, but there are no ridges; episternal suture distinct to lower side of rectangle, the ridge in front of it distinct but not as strong as is usual in *urnarius;* lower side of rectangle very weakly marked; pleura not as sericeous as in male; pubescent stripe on mesopleuron and pubescence on prothoracic lobe silvery. Petiole: first and anterior fourth of second segments black, rest of petiole red.

Described from a male and a female which have been compared with the holotype of *Sphex vulgaris* (Cresson). Male, Middle River, Minn., Aug. 9, 1935 (D. G. Denning); female, Lancaster, Minn., Aug. 26, 1936 (D. G. Denning); both are in the collection of Minnesota University.

Holotype.—Female (*Ammophila vulgaris* Cresson), Colorado; in collection of the American Entomological Society at Philadelphia.

Specimens examined: ALBERTA: Delia, male, July 22, 1935 (E. H. Strickland). BRITISH COLUMBIA: Coldstream, male. CALIFORNIA: Felton, 2 males, female, May 20–25, 1907, Sept. 6, 1908 (J. C. Bradley); Samoa, female, June 18, 1907 (J. C. Bradley). CANADA: Val Morin, 3 females, July 30, Aug. 5, 14 (C. J. Quellet). GEORGIA: Billy's Isl., Okefenokee Swamp, male, June, 1912; Honey Isl., Okefenokee Swamp, female, June 1, 1912; Spring Creek, male, May 18–21, 1916 (J. C. Bradley), 3 males, July 16–29, 1912; Stone Mountain, female, Aug. 3, 1913; Tifton, male, May 10, 1911 (J. C. Bradley); Unadilla, female, June 25, 1910 (J. C. Bradley); Warm Springs, male, July 31, 1910 (J. C. Bradley); Waycross, male, May 8, 1911. IOWA: Lyon, male, July 7, 1936 (H. E. Jaques), male, July 7, 1936 (D. Millspaugh); Mt. Pleasant, female, Oct. 22, 1934 (H. E. Jaques); Clay Co., female, Aug. 17, 1936 (Sallee); Dickinson Co., 2 males, June 26, July 10, 1936 (D. Millspaugh), male, 3 females, June 27, July 4, 28, Aug. 20, 1936 (H. E. Jaques), female, July 2, 1936 (P. Travis); Iowa Co., male, July 7, 1934 (H. C. Knutson); Jasper Co., 2 males, June 14, 1935 (H. E. Jaques); Jefferson Co., female, Oct. 11, 1936 (Linn). KANSAS: Wallace, 2 males, July, 1885; Cloud Co., male, Sept. 20 (Lantz); Riley Co., female, Sept. 11 (G. A. Dean). MICHIGAN: Mullet Lake, 2 females, Aug. 9, 10, 1935 (W. D. Murray). MINNESOTA: Ada, male, female, July 4, 6, 1911 (D. Stoner), female, July 29, 1931 (George Landsverk); Bald Eagle, male, Barden, 2 females, Aug. 25, 1922 (C. E. Mickel); Battle Creek, male, June 29, 1932 (C. E. Mickel); Caledonia, female, Aug. 16, 1934 (D. J. Pletsch); Childs, female, Aug. 7, 1932 (E. R. Tinkham); Crookston, female, Sept. 2, 1935 (D. G. Denning); Detroit, male, July 8, 1922 (C. E. Mickel); Fergus Falls, male, 2 females, Aug. 17, 21, 25, 1911 (Stoner), female, July, 1911 (Zatak); Ft. Snelling, female, June 28, 1923 (H. H. Knight), female, Aug. 2, 1923 (R. W. Dawson); Itasca, female, June 1, 1911; Jackson, 2 females, Aug. 4, 1935 (C. E. Mickel); Jordan, female, July 13, 1935 (C. E. Mickel); Lake Benton, female, Sept. 12, 1935 (C. E. Mickel); Lake City, male, June 28, 1923 (A. T. Hertig); Lake Superior, female; Lancaster, male, female, Aug. 26, 1936 (D. G. Denning); Laporte, female, Aug. 6, 1930 (D. G. Denning); Leech Lake, female, Aug. 14, 1932 (C. H.

Hoffman); Middle River, 3 males, Aug. 9, 10, 1935 (D. G. Denning); Mora, male, June 24–30, 1934 (C. R. Yeager); Plummer, female, Aug. 2, 1933 (D. G. Denning); Princeton, male, Aug. 9, 1935 (C. E. Mickel); Red Wing, male, Aug. 12, 1935 (A. B. Gurney); Rochester, female, July 10, 1922 (C. E. Mickel); St. Anthony Park, 2 males, 2 females, June 22, 1911, June 30, 1910, July 18, 1911, female, Sept. 9, 1923 (H. H. Knight); St. Paul, male, Aug. 5, 1921 (W. E. Hoffman), male, July 7, 1924 (Walter Carter), 3 males, July 1, 14, 1936 (Don Murray), female, Sept. 19, 1924 (Sam Kepperly), female, Aug. 5, 1930 (Dwight Buchanan); Sebeka, male, Aug. 9, 1936 (C. E. Mickel); Sedan, male, female, Aug. 13, 1927, July 17, 1929 (D. G. Denning); Sleepy Eye, female, July, 1911; Wall Lake, 3 females, Aug. 30, 1911, 1913; Warren, female, Aug. 5, 1935 (D. G. Denning); Willmar, female, Sept. 10, 1935 (C. E. Mickel); Benson Co., male, July 16, 1924 (Walter Carter); Big Stone Co., male (O. W. Oestlund); Blue Earth Co., male, female, Aug. 12, 1936 (S. S. Easter); Chisago Co., female (O. W. Oestlund); Dakota Co., female, Sept. 10, 1936 (P. M. Schroeder); Freeborn Co., female, Aug. 11, 1936 (E. Wolverton); Kanabec Co., male, July 15–21, 1934 (D. G. Denning); Kittson Co., male, female, June 20, Aug. 10, 1936 (D. G. Denning); Koochiching Co., 2 females (O. W. Oestlund); Lincoln Co., male, Aug. 13, 1936 (C. E. Mickel); Marshall Co., female, July 28, 1910, female, June 19, 1922 (C. E. Mickel); Pipestone Co., male, July 1, 1910; Polk Co., male, 6 females, July 1, 15, 18, Aug. 15, Sept. 1, 7, 9, 1936 (D. G. Denning), male, female, Aug. 16, 1936 (R. H. Daggy); Ramsey Co., 4 males, July 13, 1911, male, female, Aug. 18, 1921 (Arthur Hertig), 2 males, June 30, 1922 (C. E. Mickel), female, Sept. 5, 1929 (E. C. Alfonsus), female, July 25, 1932 (N. C. Sullivan), 2 females, July 25, Aug. 18, 1936 (D. J. Pletsch), 2 females; Rock Co., female, June 24, 1910; Scott Co., 2 females, Aug. 25, 1922 (A. A. Nichol); Traverse Co., male, 2 females (O. W. Oestlund); Washington Co., male, July 21, 1911, 6 males, female, July 19, 1936 (Don Murray); Yellow Medicine Co., 3 males, 4 females, Aug. 13, 1936 (C. E. Mickel); male. MONTANA: Missoula, female, July 16, 1904. NEBRASKA: Butte, male, June 25, 1931 (C. N. Ainslie); Halsey, 4 females, Sept. 1, 1924, Aug. 13, 14, 16, 1925 (R. W. Dawson). NEW JERSEY: Riverton, male, Aug. 11, 1901. NEW YORK: Adiron. Mts., female; Forest Hills, female, Sept. 11, 1914; Ithaca, 8 females, Sept. 15, 1896; female,

July 26, 1921, male, 3 females, Aug. 11, Sept. 6, 1931, Oct. 10, 1935 (P. P. Babiy), 2 males; Kinderhook, female, July 8, 1915; Middletown, female, July 2–20, 1910 (Ch. Spooner); Otto, 4 females (Comstock); Potsdam, male. NORTH DAKOTA: Beach, male, female, Aug. 22, 1921, Sept. 11, 1922 (C. N. Ainslie). OHIO: Logan Co., male, Aug., 1930 (Don Murray). PENNSYLVANIA: Philadelphia, male, Aug., 1916 (Carl Ilg); Roberts, 2 females, July 5 (J. C. Bradley). QUEBEC: Montreal, female, Aug. 17, 1901; Chambly Co., female, Sept. 11, 1901. VERMONT: Lyndonville, male, July, 1936 (Esther Smith). WASHINGTON: male, female (T. Kincaid).

Variations.—Rarely there are slight ridges on the mesonotum between the wings; all the ridges of the propodeal disk sometimes slant backwards. Male: Length 12–20 mm.; the clypeus is frequently covered so heavily with pubescence as to conceal the surface; the frontal suture does not always fade out before reaching the anterior ocellus; the second petiolar segment is sometimes entirely black, and very rarely both petiole and abdomen are entirely black; rarely there is a short dark red stripe on the dorsum of the otherwise bright red first abdominal segment; the second abdominal segment occasionally has a slight, hardly discernible bluish tint. Female: Length 13–22 mm.; the first segment of the petiole varies from entirely piceous to entirely bright red.

The most helpful characters for distinguishing *urnarius* from *kennedyi* are: in the typical *kennedyi* the costa of the front wing near the base is amber, there are no transverse ridges on the mesonotum, the episternal suture is shallow with no prominent ridge in front, the first abdominal segment is entirely red in both sexes, the abdomen has no bluish tint, there is a slight metanotal flange, the propodeal side has few or no ridges, the pubescence of the prothoracic lobe and of the mesothoracic stripe is silvery, the outer claspers of the male genitalia are thin. In the typical *urnarius* the costa of the fore wing is black or dark brownish, there are at least a few transverse ridges on the mesonotum between the wings, the episternal suture is distinct and has a ridge in front of it, the first adbominal segment has a black dorsal stripe (male only), the abdomen has a more or less prominent bluish tint, there is no metanotal flange, the propodeal side usually has some ridges, the pubescence of the prothoracic lobe and of the mesothoracic stripe is golden, the outer claspers of the male genitalia are quite broad.

This species is named after Dr. C. H. Kennedy, my graduate advisor at Ohio State University, who has believed that a study

of the male genitalia would reveal the true relationships in this genus, and who stimulated the writer to make these studies.

Sphex aberti (Haldeman).

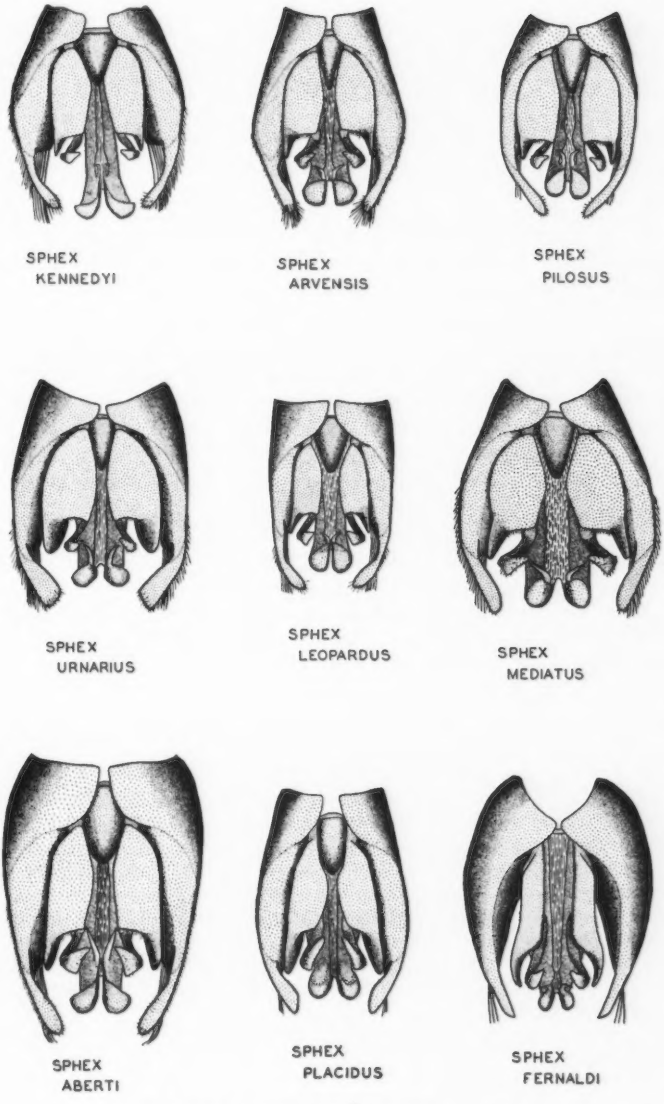
(Male genitalia on Plate I.)

Ammophila aberti Haldeman. 1853. Stans., Exp. & Surv. Salt Lake, p. 368.
Ammophila yarrowi Cresson. 1875. Rept. geog. & geol. Explor. 100th Merid., vol. 5, p. 713. Male.
Sphex transversus Fernald. 1934. N. Amer. and W. I. digger wasps of the genus *Sphex*, pp. 141–144. Male.

Sphex aberti (Hald.) was apparently described from Utah. The holotype of *Sphex transversus* Fernald was a male collected in Utah. I have examined thirteen females of *aberti* which were taken in Utah, and all agree closely with the descriptions of *aberti*. I have carefully examined eleven male specimens from Utah which are unquestionably the males of these females determined as *aberti*. These males are quite like the holotype of *transversus*. I have seen males of *aberti* from most of the western states and their genitalia are all identical with each other and with the genitalia of *transversus*. There is not, so far as I have been able to determine, any constant difference in the shape of the clypeus of these males which would warrant a separation into two species. Therefore *transversus* must become a synonym of *aberti*.

Specimens examined: ALBERTA: Lethbridge, female, Aug. 7, 1923 (Walter Carter); Tabek, female, June 30, 1923 (H. E. Gray). ARIZONA: Little Ajo Mts., Ajo, female, Aug. 28, 1931 (E. R. Tinkham); Tucson, 2 males, June 7, 14, 1924 (A. A. Nichol), female, Oct. 9, 1923. CALIFORNIA: Davis, 3 males, 3 females, Aug. 24, 1931 (H. C. Donohoe); Tulare, female, Aug. 18, 1907 (E. S. G. Titus). KANSAS: West Kansas, female Sept. 7 (Lantz); Rook Co., 3 males, July 1, 1885. NEW MEXICO: Magdalena, 2 females (Strickler). NORTH DAKOTA: Beach, 2 females (C. N. Ainslie). OKLAHOMA: Beaver, 2 females, July 27, 31, 1933 (R. Dahms), male, July 27, 1933 (E. E. Ivy); Grand, female, Aug. 16, 1933 (A. E. Pritchard); Kenton, 2 males, 3 females, June 21, 29, 1933 (A. E. Pritchard), male, June 22, 1933 (E. E. Ivy), 2 males, June 27, 1933 (W. Chiles); Laverne, Aug. 7, 1933 (R. Dahms); Optima, July 24, 1933 (A. E. Pritchard); Quinton, June 10, 1934; Shattuck, Aug. 12, 1933 (E. E. Ivy); Vinson, 6 males, 3 females, July 9, 1934 (J. Stankavich), 4 females, July 9, 1934 (A. E. Pritchard); Beaver Co., May (?) 2, 1932 (C. C. Deonier). UTAH: Benson Wd.,

female, July 23, 1909 (Titus & Hoff.); Corrine, 3 males, June 22, 1929 (G. F. Knowlton & M. F. Bowen); Farmington, female, July 17, 1930 (Melvin J. Janes); Far West, female, Sept. 15, 1932 (Lowell Cutler); Ft. Duchesne, 2 males, July 12, Aug. 18, 1932 (Lowell Cutler), female, June 12, 1930 (Ray L. Janes), female, Aug. 6, 1932 (F. K. Stoffers); Iosepa, male, July 30, 1932 (G. F. Knowlton); Lempe, female, July 7, 1931 (G. F. Knowlton); Logan, male, female, July 2, 1909, Aug. 4, 1931, male, July 17, 1932 (J. H. Linford), female, July 1, 1933 (L. Green); Myton, female, Aug. 23, 1932 (Lowell Cutler); Park Valley, male, May 2, 1934 (R. C. Roskelley); Snowville, 2 females, Sept. 21, 1932 (Lowell Cutler); Emery Co., 2 males, 2 females, Aug. 18, 23, Sept. 3, 6, 1921 (G. O. Wiley).



Ventral view of male genitalia in the genus Sphex

THE BIOLOGY OF CEPHALONOMIA TARSALIS (ASH.), A VESPOID WASP (BETHYLIDAE: HYMENOPTERA) PARASITIC ON THE SAWTOOTHED GRAIN BEETLE[1]

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In habits this fossorial wasp very nearly approaches the dividing line between the true fossorial and true parasitic wasps. It was discovered at Urbana, Illinois, October, 1934, in cornmeal as a parasite of the common saw-toothed grain beetle, *Oryzaephilus surinamensis* (Linn.). As very little work had ever been done on the habits of this parasite, it was considered appropriate to study its biology in detail. The problem was done under the supervision of Dr. C. L. Metcalf, Head of the Department of Entomology, University of Illinois, to whom the writer is greatly indebted for many valuable criticisms and suggestions.

OVIPOSITION

The adult female may parasitize either a larva or pupa of the saw-toothed grain beetle, although the larval forms are more commonly attacked. The host is first paralyzed by a sting. After complete submission of the host larva, the parasite may either drag or carry her prey to a sufficiently good hiding place and within a short time deposits her eggs.

The eggs are deposited in pairs on the thoracic segments of the host. In fifteen different cases in which a fertilized female was observed to deposit eggs, a female egg was deposited first on the prothoracic segment and within a short time a male egg was deposited on the mesothoracic segment. Although the eggs were always deposited on the thoracic segments, their arrangement was variable. Eggs were observed on opposite sides of two different segments, on the same sides of two different segments, on opposite sides of one segment, or on the same side of one segment with one egg below the other. Under normal conditions there were never more than two parasite eggs deposited on a single host larva. Under abnormal conditions such as in small cultures with only a few host larvae, four eggs were often deposited by the parasite on one host larva.

Hatching of the egg occurred within twenty-four hours after oviposition.

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[1]Contribution from the Entomological Laboratories of the University of Illinois, No. 196.

THE LARVA

The young larva upon hatching is approximately 0.5 mm. in length. It breaks through the egg shell at a point adjacent to the host and protrudes the anterior part of its body through the body wall of the host to feed internally. Only the head and prothoracic segment are inside of the host while the remainder of the body is outside. The retrorse prothoracic spinules furnish ample means of attachment to the host (Fig. 5). Segmentation is not visible until about forty-eight hours after hatching. The principal indication that it is a larva, and not an egg, is the repeated contraction and expansion of the digestive tract which is caused by the ingestion of food. The respiratory tract is also visible, the five spiracles being a means of determining the indefinite segmentation of the newly hatched larva (Fig. 4).

As feeding continues and the body of the parasite larva increases in size, the egg shell is gradually pulled back until it hangs like a limp sack on the caudal segments of the abdomen (Fig. 4). Within a very short time the shell completely shrivels up to become practically invisible. It is actually visible for not more than two hours after hatching occurs.

Four days later, all but the external skin of the host has been devoured. The feeding time varies slightly in relation to the number of parasites on a single host larva. Never more than two parasites will develop fully on one host. Two parasites will completely consume a host larva in approximately two-thirds of the time required for one individual. The additional food which the latter individual receives, however, is not necessary for normal development.

Within two hours after feeding has been completed, the parasite larva begins spinning a cocoon. A continuous strand of silk is secreted from the spinneret and is placed at rather indefinite points, finally forming a small, yellowish, silken cocoon. In detail, the larva lies on its back, curled, with its head and anal segment in contact. This contact makes possible the attaching of the silk to the anal region. The body is straightened out then, with the strand extending from the spinneret to the caudal end of the body. The next step is for the larva to turn sidewise, press the spinneret to the substratum, and leave the strand attached there. On its back again, it curls and repeats the same movements except that the second time the strand of silk is attached approximately 0.5 mm. posteriorly from the point at which the first attachment was made. Up to this point, two loops of silk are over the anal segment. As the body curls upward the third time, there is a tendency for the old strands, as they harden, to form an outward curved condition and to break loose from the anal attachment. Thus, as the series of basal attachments proceeds backward, the first strands lie over the body, becoming pushed upward, and lodged with other strands to form a neat little covering over the larva. The adherence of the silk to the surface may be made on either side of the body. Sometimes the opposite sidewise movements are made alternately, but the pattern is not definitely in that manner; that is, two or three attachments may be made on one side before one is made on the other.

The general position of the body with regard to the position of the cocoon remains unchanged throughout the entire process.

After a period of from four to six hours, the cocoon is finished. The larva becomes inactive, and the individual remains quiescent throughout pupation.

THE PUPA

The pupal period is the longest and most resistant immature stage of this insect. The winter months are passed in this condition. The tough silken cocoon furnishes ample protection from the predaceous species in the grain. Small parasitic mites find it impossible to gain entrance into the tightly woven cases (Fig. 3). Several exposed pupae were destroyed by *Tribolium* spp. and parasitic mites within a very short time. It is evident, then, that the little cocoons play an important part in the protection and survival of this species.

During the prepupal stage, the body loses its fleshiness. The segments become very distinct, and there is a conspicuous decrease in size (Fig. 8). This is due mainly to the discharging of the fecal matter shortly after quiescence begins. The anus opens to release a dark, granulated fluid which soaks through to the exterior of the cocoon. Within a short time the fluid hardens and serves as a posterior anchor to the substratum. The anchor is more sturdy than one would imagine. As the fluid drys the entire body of the parasite is slowly lifted upward until it is poised with its head against the roof of the cocoon. When not in a cocoon, the body may be lifted to an approximate sixty-degree angle. In the latter case, of course, the roof of the cocoon does not interfere. Where the body cannot be raised higher than at a thirty-degree angle because of the roof of the cocoon, a definite body tension must be produced as the fecal matter continues to dry. This may or may not be of some significance in the development of this species.

The suspension of the body in the air appears to have some significance. The development of several individuals was either greatly decreased or halted entirely by breaking the anal adhesions and allowing the individuals to lie on their entire ventral surface. This disturbance was attributed to a sticky dampness which formed, in each case, between the body and the surface of the rearing box. In cases where individuals were allowed to roll around in the box, the development was not retarded. This proved that it was the condition and not the position of the individuals that brought on the harmful effects.

For seven or eight days, following the ecdysis of the prepupal skin, no noticeable change occurs. The abdomen then begins to darken slightly. After another day, the entire body becomes a dark gray to black. At this time ecdysis to the adult occurs. The individual is rather active and will move around considerably, but it requires four or five days before it accumulates enough strength to gnaw itself free from the cocoon. Exposed adults are extremely awkward during this period. When they attempt to walk, their legs become spread in all directions, finally to give away entirely. These individuals become normally active, however, two or three days sooner than ones which are enclosed in cocoons until ready for emergence.

THE MALE AND FEMALE ADULTS

The male parasite emerges about two days prior to the female. In cases where male and female pairs were reared together, the male on emerging from his cocoon would enter the female cocoon and copulate with her inside the cocoon. A single male would mate with many different females. A female would mate only once. The male parasite apparently has no other active duties than copulation during his short life period of six days. He takes no part in aiding the female with her prey, nor does he consume food. Males isolated in clean glass vials lived as long as males which were placed under normal conditions.

The female parasite (Fig. 9) is very active and is constantly searching for new hosts or will spend days taking care of the one she may have. Parthenogenesis is exhibited by this species. Virgin females will produce an average of fifty eggs each. Virgin females produce only males, but fertilized females produce both males and females. The fertilized females yield an average of eighty-five eggs each. Both fertilized and unfertilized females live an average life of about thirty-five days.

ECONOMIC SIGNIFICANCE

It is very evident that this species is not of economic importance in the control of *Oryzaephilus surinamensis* (Linn.). It is too susceptible to environmental resistance factors or to the destructive elements of its habitat. The adult appears to be aggressive enough in regard to its own welfare, but the powers of reproduction are extremely low.

A pure culture of saw-toothed grain beetles, which were infested with this parasite, was under observation for three months. An average number of four parasites was encountered each time this culture was examined. Within this same time it was necessary to remove hundreds of saw-toothed grain beetles in order to maintain an uncrowded culture. Thus, fairly definite conclusions could be made regarding the relative numbers of parasites and hosts. The number of individuals of the parasite remained fairly constant over a period of three months while the number of host individuals steadily increased.

SUMMARY AND CONCLUSIONS

Cephalonomia tarsalis is one of the fossorial wasps, of the family Bethylidae, and is a parasite of *Oryzaephilus surinamensis*.

Only larval and pupal forms of the host are parasitized. The female stings the host form before it is parasitized. Parasite eggs are deposited in pairs on the external portions of the thoracic segments of the paralyzed host. Fertilized females always deposit a male and female egg on a single host form. The eggs hatch within twenty-four hours after being deposited. The young, legless, translucent larva breaks through the body wall of the host with its mouthparts and feeds internally.

The host, except the external skin, is consumed in about four days. The larva then commences spinning its cocoon. After a period of ten days the adult emerges.

Unfertilized females produce only male offspring, but the fertilized female produces both male and female offspring. Virgin females will deposit about fifty eggs during their lifetime, and fertilized females will deposit about eighty-five eggs during the same period of time. The average life of both female forms is about thirty-five days.

The male lives only about six days during which time he may copulate with several females. He apparently consumes no food during his existence.

This species is not of economic importance in the control of the common saw-toothed grain beetle.

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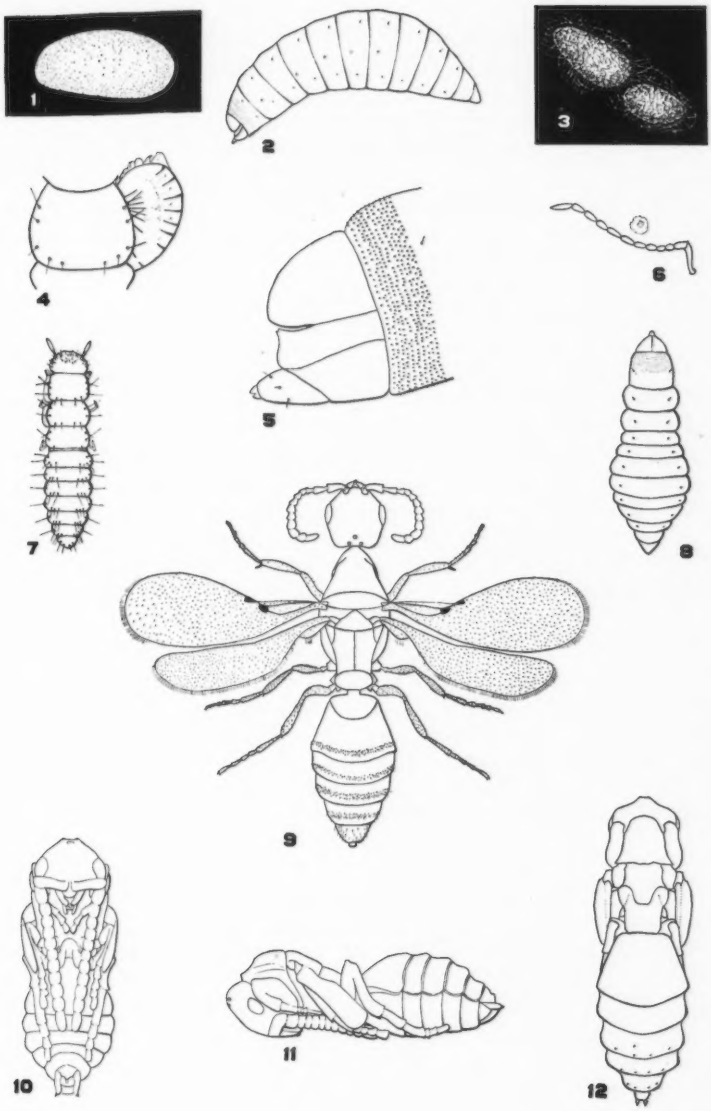
EXPLANATION OF PLATE

Fig. 1. Egg of parasite, *Cephalonomia tarsalis*. (× 83.) Fig. 2. Lateral aspect of mature parasite larva. (× 20.) Fig. 3. Pupal cases of parasite. (× 8.) Fig. 4. Prothorax of host with a newly hatched parasite larva attached. Remnants of the egg shell still remain on the caudal portion of the young larva. (× 48.) Fig. 5. Lateral aspect of head and prothorax of parasite larva. (× 200.) Fig. 6. Antenna of male adult parasite. (× 29.) Fig. 7. Mature larva of the host, *Oryzaephilus surinamensis*, with parasite eggs attached to the thoracic segments. (× 16.) Fig. 8. Dorsal view of prepupa of parasite. (× 29.) Fig. 9. Dorsal view of female adult parasite. (× 29.) Fig. 10. Ventral aspect of male pupa of parasite. (× 30.) Fig. 11. Lateral aspect of female pupa of parasite. (× 30.) Fig. 12. Dorsal aspect of female pupa of parasite. (× 30.)

Cephalonomia, Parasitic Vespoid
Dwight Powell

PLATE I



POPULATION STUDIES OF FORMICA EXSECTOIDES FOREL

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The Eastern mound building ant, *Formica exsectoides* Forel, has been widely reported over the Northeastern United States, and has been the subject of many studies by Andrews, McCook, Pierson and Wheeler, and scattered accounts from others. Andrews' studies have been largely conducted in Maryland. The insect is present in numbers, in widely separated areas in the State, but no complete survey has been made to ascertain its exact distribution. North of Baltimore, in Baltimore County, there are many mounds. In Prince George's and Montgomery Counties, in the northwestern corner of the former county and adjacent parts of Montgomery County, there is a large area inhabited by this insect. A single colony was located almost at the summit of Round Top, an isolated spur at Hancock, Washington County, with an elevation of approximately 1400 feet.

These studies concerned the population of one large nest and one medium sized nest as a basis for estimating the total population in a ten-acre plot selected as representative of the usual type of infestation. In addition to the population studies, data were secured on the nest structure, position of the nest with relation to light and shade, trees, distribution of nests with relation to terrain, some habits of the ants, and collection of their myrmecophila.

POPULATION OF TWO MOUNDS

The first mound studied was located in a woods about three-fourths of a mile southeast of Fairland, Montgomery County. It was surrounded on the north and west by a growth of pine, oak, hickory, maple and gum. There were no trees on the southwest for approximately a rod, thus allowing the afternoon sun to shine on the nest. Two dead scrub pines, one inch in diameter, stood close to the edge of the nest. Laurel and huckleberry bushes were growing vigorously at the edge of the mound. The ground sloped to the west, but was rather low and quite damp after rains. The soil was covered with leaves, sticks and pine needles. The top inch or so of soil was rich woods loam. Below that was sandy loam containing a few stones.

Nest No. 1 was 19 inches high and 180 inches around at the ground level. The diameter of the mound was 47 inches. The mound was very regular with no grass growing on it, but many pine needles were sticking in it. The only openings were at the base of the mound. Two underground runways were found leading out into the woods to the west and north. One was traced to the foot of a tree a rod away. These runways were an inch in diameter and were in the porous, woods loam layer.

Excavation was started October 10, 1935, and was continued almost daily until December 1st. When cut open, the mound was found to be filled with passageways arranged roughly in stories. Very few ants were found in the mound and these were not closely packed in masses. All were the larger workers and were found singly or in groups of two or three in the passageways. Hibernation starts early and the ants do not remain in the mound during the winter, but retire to the passageways below the ground level.

The ants were found in the passageways from about soil level to a depth of 31 inches. Some of these passageways were packed with ants for many inches. In others spaces of an inch or two were left unoccupied between masses. The ants were closely pressed in the passageways with their legs intertwined. The queens were found mixed with workers, below ground level. The two sizes of workers were mixed rather indiscriminately, except that the larger ones were the only ones found in the mound.

After excavation it was found that the main nest had a diameter of 72 inches, and was roughly circular in outline. The shallow side part was 77 inches east and west, and from 44 to 72 inches north and south. An underground runway was near this longer north side.

The depth of this shallow part varied from 1 to 12 inches. The deeper part was close to the main nest. The main nest had rather abrupt sides which were about 21 inches high. The main floor level was around 22 inches, but at several places deep holes had to be dug to follow passageways that ran down as much as 10 inches farther.

Two gills of ants were counted, which averaged 4,450 ants per gill. The ants were removed and preserved and later measured and the total estimated as 237,103. Of this total 8,325 were actually counted at the nest site and discarded. There were 1,407 queens; one of these was found in March when the nest site was revisited, 110 were in the shallow part of the nest, and the balance, 1,296, in the main part. There were 168.5 workers for each queen.

If an average depth of 27 inches is allowed for the main nest and it is considered circular with a diameter of 70 inches it would contain 103,908.42 cubic inches. The shallow part has 24,486 cubic inches when calculated as having dimensions of 77 by 53 inches and an average depth of 6 inches. This totals 128,394.42 cubic inches for this nest.

A study of nest No. 2 was started on April 8. It was necessary to fumigate this nest with carbon disulphide and, therefore, the count may not be quite as accurate as the count on the hibernating ants. This nest was located a few yards east and south of nest No. 1. It had a partly dead oak, two inches in diameter, close to one side. The

location was in a low area, and water seeped into the excavation to a depth of one or two inches each night. The mound was 11 inches high and 106 inches in circumference. The diameter at the base of the mound was 34 inches. The surface of the mound was smooth with no grass, but pine needles and small sticks adhered to, or protruded from the surface. Numerous passageways extended under the mound for a distance of about ten inches straight down and out to 2 or 3 inches beyond the base of the mound. Isolated passageways extended to a depth of 21 inches and laterally as much as 10 inches beyond the base of the mound.

The ants filled the passageways for inches at a time, especially in the area immediately under the mound and within 10 inches of the surface. The deeper passageways had frequent spaces between the clusters of ants. The queens were found singly among the workers, generally where all the passageways were filled with closely massed workers. A few clusters of ants were found that had been dead before the poison was introduced. These were in the deepest passages and in ones far removed from the center of the nest.

After excavation was completed it was found that the nest was 48 inches wide, east and west, and 41 inches wide in a north and south direction. The sides sloped rather abruptly down to a depth of 22 inches. There were no small especially deep spots. The nest did not extend under the tree.

There were nine gills, plus 1,276 workers, estimated as a total of 41,326 and 40 queens. There were 1,033.15 workers to each queen. The nest contained 36,744.13 cubic inches. The ratio of cubic contents of Nest No. 1 to Nest No. 2 was nearly 3.5 to 1. The mound alone had a ratio of about three to one. Nest No. 1 contained 5.7 times as many ants and 35 times as many queens as Nest No. 2.

POPULATION STUDIES OF A SELECTED AREA

The nests in a 10 acre area in which the two excavated nests were located were carefully studied in May. A wood road cut through a corner of this land. The southwest corner was open, small parts having been cultivated and then left to blackberries and grass. The nests in this part were not very large and sometimes showed that the mound had been dug into or damaged in various ways. Most of the nests were near the edge of the clearing. From the wood road and this cleared part, the ground sloped east, except for the eastern edge which was higher. The water drained into tiny streams which united and flowed south. The southeast corner was higher, but rather flat and in wet weather inclined to be very damp. About the middle of the north side along the road there was a swampy area, caused by the road construction, that drained to the north. The soil of this area is Leonardtown silt loan. One place showed a tendency to be quite gravely, and gravel and stone were found in the nests excavated. The cultivated corner contained somewhat heavier soil. The southwest corner was cleared and cultivated sporadically. The rest was covered with trees and shrubs. These were mostly pine, oak, tulip poplar, hickory,

dogwood, laurel, huckleberry, greenbrier, blackberry. The southeast corner had the thickest stand of large pine with a scarcity of undergrowth. Very few nests were found in this corner. On the west border, about half way from north to south, an area had been cut over recently. Young growth was developing rapidly, and the ants' nests were closer together here. The remainder of the area contained more large oaks, with fewer but larger and active nests.

The nests, 73 in number, are not evenly distributed over the area. They average 7 to the acre, which is very much less than McCook found in Pennsylvania in 1877, or Andrews in the same place in 1925.

Since sunlight has been suggested as a necessary factor for these ants, the position of each nest relative to sunlight was noted. This was done in May when it was possible to note the relative amount of activity in each nest. In Table I, these facts are given, together with the height of each nest. Each nest was photographed and given a number corresponding to those in Table I.

In the table the mounds are grouped according to their position relative to trees. Fourteen mounds were in the open, that is, no trees were close enough to throw a shadow on the mounds after the sun was high. Of this group only one mound was 20 inches high. Three mounds were less than 10 inches high. The rest were from 10 to 17 inches high. All but three of these 14 nests were only moderately active. This means that some ants were crawling over the undisturbed mound and more appeared when the nest was approached closely. Great activity means that the ants were numerous over the mound when undisturbed and when closely approached, swarmed out of the openings and over all the mound and surrounding ground.

The next group of 12 hills, all moderately active, were near enough to trees on one side, so that they were in the shade part of the morning or afternoon. The heights ranged from 12 to 20 inches.

The next section of the table groups those hills that were close to trees on one side so that they were shaded for half of the day. Mound No. 1 is listed here, although the activity in May could not be determined. The fifteen mounds remaining varied in height from 11 to 20 inches. The one 4 inches high was very evidently a new mound and was close to the larger hill. Of this group two mounds were double, or at least two were very close together. Both showed great activity. One other nest showed great activity.

Twelve mounds were found surrounded by trees that shaded the hill except for a few hours each day. The sunlight generally could fall directly on the mound near the middle of the day. This group shows variety in activity and height. Three nests showed little activity. Fresh pellets were present on the mound, and a few ants were about, but the mound could be approached closely without increasing the activity. One of these nests was much flattened, but was large in circumference at the base. One mound 20 inches high showed moderate activity while the rest showed great activity. Their height ranged from 5 to 25 inches, the largest found in the ten acres.

The remaining mounds were in at least partial shade all the time. The trees were large and close enough to exclude any considerable

TABLE I

LOCATION AND SIZE OF MOUND IN RELATION TO GENERAL ACTIVITY OF ITS POPULATION

IN OPEN			NEAR SOME SHADE		
Record No. of mound	Height in inches	Activity	Record No. of mound	Height in inches	Activity
23	12	Moderate	7	20	Moderate
24	12	"	8	12	"
26	10	"	9	12	"
28	13	"	14	13	"
32	9	"	15	15	"
37	13*	"	16	15	"
39	11*	"	17	12	"
41	8	"	22	13	"
42	12*	"	29	18	"
43	7	"	36	14	"
45	13	"	38	17	"
34	20	Great	46	17	"
40	14*	"			
44	17	"			

TREES ON ONE SIDE			TREES SURROUNDING NEST		
Record No. of mound	Height in inches	Activity	Record No. of mound	Height in inches	Activity
4	20	Moderate	13	14	Little
5	19	"	10	19	"
6	16	"	19	7*	"
11	16	"	33	20	Moderate
12	11	"	3	18	Great
18	11	"	47	23	"
70	13	"	48	19	"
27	10	"	49	25	"
30	13	"	50	5	"
31	13	"	51	13	"
65	17	Great	68	21	"
20	18	"	2	11	Excavated
20	4	"			
21	12	"			
21	19	"			
1	19	Excavated			

BRANCHES OVERLAP OVER AND AROUND NEST					
Record No. of mound	Height in inches	Activity	Record No. of mound	Height in inches	Activity
67	15*	Little	62	21	Great
69	13	"	61	13	"
35	12	"	60	24	"
25	19	Moderate	59	15	"
52	13	"	59	7	"
54	12	"	58	23	"
55	13	"	57	20	"
64	12	"	56	17	"
66	18	Great	53	24	"
63	15	"			

*Mound damaged which may have reduced height.

quantity of sunlight. Three medium sized nests showed little activity. Five mounds ranging from 12 to 19 inches in height were moderately active. The remaining 10 showed great activity. One of these was almost united with another half its height. All of them were more than 13 inches high; two hills were 24 inches high.

In this ten acres the position of mounds in relation to sunlight does not seem to have a clear cut effect on the height or activity. The more shaded areas had more active nests, but they were farther apart and in a more undisturbed section of the woods.

Several abandoned nests were found, some of which were well rounded mounds, although they were always more flattened than the active nests and generally had moss and lichens on them. There was no regularity in the position of these nests in relation to active nests.

TOTAL POPULATION OF TEN ACRES

On the assumption that mounds of the same height, in this rather homogeneous group of nests, would have the same population, the entire number have been grouped around the heights of the two nests excavated.

The height most frequently found is 13 inches. There are 14 mounds of this height. There are 10 hills 12 inches high. The rest of the heights are less frequently represented. There are 6 mounds 19 inches high and 4 hills 11 inches high. Eleven nests are over 19 inches high and 9 less than 11 inches. Forty-three nests range in height from 12 to 18 inches.

The 6 nests 19 inches high should contain, on the basis of the estimated population of Nest No. 1, 1,431,060 ants. The 4 mounds, 11 inches high, should contain 165,464 ants. For the mounds with heights between 11 and 19 inches two possibilities present themselves. One is to use two-thirds the number in Nest No. 1 as a fair estimate of each nest in this group of nests. These 43 nests should have an estimated population of 6,837,286 ants. The other possibility is to find the average of Nests No. 1 and No. 2 and use this. Most of the 43 nests were of moderate activity and the number fairly well distributed among the different heights. The average of the population of the two nests is 139,938. This gives an estimated population by this method of 6,017,234 ants.

The 9 nests less than 11 inches high vary from 4 to 10 inches in height. One-half the size of Nest No. 2 or 20,683 ants might be used as a conservative estimate for the population of each. This will total 186,147 ants. The same method can be used in estimating the per nest population of the 11 hills over 19 inches high. One and one-half times the population of Nest No. 1 is 357,765. This gives an estimated total for these nests of 3,935,415 ants. When these estimates of groups are added there are a possible 12,555,372 ants by the first method or 11,735,320 ants by the second method. The density of the population is clearer when it is realized that these figures mean there is an average of about 27 ants for every square foot of the ten acres.

SUMMARY

1. The estimated population of two colonies was 238,510 and 41,366 ants respectively.

2. Seventy-three mounds were located, charted and measured in 10 acres.

3. Assuming a correlation between height of mounds and population the total number of ants in the 10 acres amounted to 12,555,372 by one method or 11,735,320 by a second method.

4. No consistent correlation between shade around mounds, their height, and the amount of activity was found.

Sectional view of ant hill No. 1.

STUDIES IN THE TIPHIIDAE (HYMENOPTERA: ACULEATA)

III. Description of a New Species of *Neotiphia*[1]

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Neotiphia carinata, sp. nov.

Male.—13 mm. long. Black: palpi, mandibles medianly, tibial spurs and the apices of the tarsal joints of the fore and middle legs obscurely ferruginous. Head, thorax and abdomen with abundant erect, glittering white pubescence.

Wings hyaline; stigma black; veins of forewing dark brown, of hind wing testaceous.

Head shining and coarsely punctured; lower half of front more closely punctured than the upper half and vertex; clypeus dull, convex and bipunctate, its anterior margin thickened, sulcate and tridentate.

Thorax shining and coarsely punctured; pronotum with the transverse carina complete; scutellum with large scattered punctures except apically where they are more concentrated; postscutellum very closely punctured; propodeum dull, the areola almost parallel-sided, tapering only slightly toward the apex and with a median longitudinal carina reaching two-thirds of the way toward the apex; carinae separating the dorsal from the posterior and the posterior from the lateral surfaces of the propodeum well-developed; mesepisternum bipunctate; tegula broader than long, its posterior margin not thickened and with a posterior groove only; sensorium of hind tibia deep and elongate.

Abdomen shining and coarsely punctured; the first two and last two tergites more closely punctured than the intervening ones; median depression of sixth sternite with well-developed lateral carinae and also with a complete median carina; pygidium with a median longitudinal carina.

Female, unknown.

Holotype: 1 ♂, Sierra Ancha Mountains, Arizona, August 25 (D. K. Duncan). The unique type is retained in my collection.

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[1]The articles in this series completed prior to the present contribution are as follows:

I. A Review of the Genera of Myzininae. Ann. Ent. Soc. Amer., XXX: 26–30, 1937.

II. A Revision of the North American Myzininae. Trans. Amer. Ent. Soc. (In Press.)

N. carinata sp. nov. is most closely related to *N. cockerelli* Allen which has been described only recently.[2] I compared the holotype of *carinata* with that of *cockerelli* (both are known from unique males) while at the National Museum several years ago and find that they may be separated by the following characters:

Apex of areola almost as wide as base, the median longitudinal carina well-developed; pygidium with a pronounced median longitudinal carina; median carina of last sternite well-developed; lateral carina of last sternite more pronounced; carinae separating the posterior and lateral surfaces of the propodeum well-developed; antennae black; mandibles black except medianly.....**carinata**

Apex of areola only about half as wide as base, the median carina absent; pygidium without a median longitudinal carina; median and lateral carinae of last sternite not so well-developed; carinae separating the posterior and lateral surfaces of the propodeum not very pronounced; antennae, except scape, ferruginous; mandibles ferruginous except apices.....**cockerelli**

Eventually *N. carinata* sp. nov. may prove to be conspecific with *N. novomexicana* Allen (known only from the female) as I have one female of the latter species bearing the same locality and date as the holotype of *carinata*. This record extends the known range of *novomexicana* which previously was known only from the unique type from New Mexico.

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[2]Allen, H. W. North American Wasps of the Genus *Neotiphia*. Trans. Am. Ent. Soc., LXI: 53–65, 1935.

CHECK LIST OF THE CICADELLIDAE (HOMOPTERA) OF NORTH AMERICA, by DWIGHT M. DELONG and JOHN S. CALDWELL. 95 pp. 1937. (Mimeograph.) Published by the authors. Price, $1.25. Copies may be obtained by writing Irona S. Winterrowd, Dept. of Zoology and Entomology, Ohio State University, Columbus, Ohio.

This much needed check list of the Cicadellidae containing the described North America genera and species, has just been published in mimeograph form. It comprises 145 genera and more than 1800 species as mentioned in literature up to September, 1937, with distribution records and citations to the original descriptions. An index to genera is included which is arranged phylogenetically.

The mimeographing has been well done and the booklet is neatly bound in an attractive heavy paper cover.—R. H. D.

THE MALPIGHIAN TUBULES IN THE ADULT MELANOTUS COMMUNIS GYLL.[1] (ELATERIDAE: COLEOPTERA)

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Although there are many embryological and morphological studies of the Malpighian tubules of insects, the questions still remain as to whether the tubules in different insects enter the hind-intestine or the mid-intestine, whether the edge of the cell toward the lumen is striated or covered with a chitinous intima and whether the tubules are ectodermal or endodermal in origin. In *Melanotus communis* four tubules enter the mid-intestine just anterior to the pyloric valve. These tubules are united in pairs by the peritoneal epithelium so that they appear as two continuous loops. The striated border epithelium lining the tubules can be divided into two types: (a) small columnar cells near the insertion of the tubule and (b) large pyramidal cells along the rest of the tubule.

METHOD

The beetles were hibernating when collected, usually in aggregation. They were kept dormant by refrigeration until needed and were then dissected. Even in these dormant insects the cells of the mid-intestine were apparently secreting and the lumen of the tube was usually distended with a yellow or brown fluid.

The beetles were dissected in a Ringer's solution modified for insects.[2] Following a mid-dorsal incision, the digestive tract was severed in the region of the prothorax, drawn outside of the body with the attached tubules and pinned against the black wax bed of the dish. The tubules were then freed from their tracheal attachments and stretched out on either side of the intestine. In this position they could be readily examined for gross structure. They were mounted in water or glycerine on glass slides for closer inspection. For serial sections, the digestive tube and tubules were fixed in either Carnoy (6–3–1), mercuric chloride, osmic acid vapor, or the fluids of Helly and Regaud (with or without mordanting in potassium dichromate).

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[1]We wish to acknowledge our indebtedness to Doctor Edwin C. Van Dyke, of the University of California, for the identification of the beetle.

[2]The formula for the modified Ringer's solution for insects is the following: NaCl 5.5 grams, KCl 0.14 grams, $CaCl_2$ 0.12 grams made up to 1000 cc. with spring water. (Courtesy of Doctor S. I. Kornhauser.)

Helly's fixer seemed the most satisfactory for general purposes. The sections were usually stained in Mayer's hematoxylin followed by eosin, light green, orange G, or Mallory's connective tissue stain. Other stains were also employed (Table I).

OBSERVATIONS

The four Malpighian tubules of *Melanotus communis* insert at the posterior end of the mid-intestine just anterior to the pyloric valve (fig. 6). From their origin they run cephalad into the thorax, there turn on themselves and go caudad. In the region between the second and fourth sternites, the tubules become tightly snarled about the hind-intestine, tied to it and to each other by many tracheae. More posteriorly they spread out laterally in pairs ending in the fat body. Under low magnification it is sometimes possible to see the tips very close to or touching each other. With higher powers these tips of the tubules are seen to be held to each other by the fusion of their peritoneal sheaths (figs. 3 and 4). Two superficial loops are therefore formed from the four tubules. Figure one shows two such loops. The upper one is intact; the lower one (seen in part) was broken when the tubule was being arranged for the photograph. Since most of the alimentary canal is present in the picture the much greater length of the tubules may be seen in comparison.

Histologically a tubule consists of two regions differing from each other in their type of lining epithelium. The "proximal region" is short, about a millimeter in length near the insertion and characterized by small columnar cells about 16 micra high (fig. 6). A cross section in this part cuts as many as 20 cells. The total diameter of the living tubules in this region is about 82 micra.

The "distal region" makes up the greater length of the tubule, approximately 18 millimeters. Here the cells are large and pyramidal in shape and with big nuclei which usually bulge into the lumen of the tubule (figs. 2 and 5). A cross section usually includes 6 or fewer cells, which may practically occlude the lumen. Because of these large cells, the total diameter of this part of the tubule is but little less than that of the proximal.

The nuclei of the epithelial cells are discrete both in the fresh and in the fixed material because of their distinct nuclear membranes (fig. 5). In the proximal region they are either round or irregular, sometimes somewhat brick-shaped. The latter appearance may be due to distortion in fixation, since it occurs only in prepared material (fig. 6). Those of the distal region are round, oval, or bean-shaped, depending on the plane of section (figs. 2–5).

The cytoplasm of the living cells is filled with minute yellow highly refractive spherules of approximately equal size. These are so much more abundant distally that the region appears yellowish to the naked eye. Mitochondria have been demonstrated both in the living cells supravitally stained in a 1:33,300 dilution of Janus green and in cells fixed in Regaud and stained in analine acid fuchsin and methyl green. They appear as very minute granules usually arranged in chains. In the fixed material they occur near the bases of the cells, but may extend toward the striated border which also stains with the fuchsin.

The striated border of the cells is near the lumen but within the cytoplasm. The cell membrane forms a more or less distinct line over the tops of the striations (fig. 2). In fresh tissue the border appears as a band of alternately dark and light stripes. However, fresh material treated with aceto-carmine shows no striated border, but the region corresponding to it is composed of clear non-granular cytoplasm bounded by the definite cell membrane. Table I summarizes the reactions of the cytoplasm and striated border to various fixers and stains. In the Regaud fixed material the striations appear as heavy lines of granules which are continuous with the less dense granular cytoplasm (fig. 5). After treatment with the other fixers the transition between the basal cytoplasm and the border is sharp and the striations are more obviously filiform (fig. 2).

TABLE I

STAINING REACTIONS OF THE CELLS OF THE MALPIGHIAN TUBULES OF *Melanotus communis* AFTER VARIOUS FIXITIVES

Fixer	Stain	Color of	
		Cytoplasm	Striated Border
	Aceto-carmine	Pink	No striations[3]
Carnoy (6-3-1)	Eosin	Pink	Pink
	Orange G	Yellow	Yellow
Mercuric Chloride	Eosin	Pink	Pink
Zenker-formol (Helly)	Eosin	Pink	Pink
	Light green	Green	Green
	Orange G	Yellow	Yellow
	Mallory's C. T.	Reddish blue	Blue
	Methylene blue and eosin	Blue	Pink
Regaud	Analine acid fuchsin, methyl green	Pale green	Red
	Iron hematoxylin	No stain	Dark grey

In *Melanotus communis* the Malpighian tubules arise between an undifferentiated clump of cells and the glandular cells of the mid-intestine. This clump of indifferent, unchitinized cells is followed by the characteristic cells of the pyloric valve. The hind-intestine is lined by a chitinous intima which continues over the high columnar cells of the pyloric valve, gradually decreasing in amount anteriorly (fig. 6). In many cases these indifferent cells are similar to those of the regenerative nidi of the mid-intestine in close approximation to the origin of the tubule (fig. 6).

In 22 slides showing 43 examples of the entrance of the tubules, one case was found in which a tubule appeared to enter the hind-intestine below the pyloric valve. In the sequence of sections, however, the lumen of this tubule never broke through to the cavity of the intestine. Since four tubules (the usual number) did enter the mid-intestine in this

[3]Striations visible, at least in distal cells, unless as here a statement is made to the contrary.

animal and since the cells of this tubule were those characteristic of the distal and not the proximal end, it has been concluded that this is an aberrant structure.

The connection between the distal tips of the tubules is so delicate that it was invariably broken in dissecting during the early part of the work. Thus the tubules appeared to end separately. Occasionally wisps of sheath tissue were found extending from the tips indicating that they had been attached to some organ. In the later part of the study, attention was concentrated on the problem of finding this attachment. It was then seen that the sheath between the two tubules was continuous. The epithelium of one tubule was in no case contiguous with that of its fellow, but the two were separated by a capping of sheath cells (fig. 4). Twenty-seven beetles were dissected in this study of the loop. Of the 54 possible loops in the 27 animals, 42 were seen clearly, 11 were not plainly visible because of the destruction of organs. In one case there was no loop. The loops were formed by loosely connected tips (fig. 3) and also by ones intimately fused (fig. 4). The former were much more common, perhaps because closer connections had been stretched in the manipulations. In the one case in which there was no loop, one tip was connected by tracheae to the digestive tract in the metathorax and the other tubule ended posteriorly in the fat body.

DISCUSSION

The distal cells in the Malpighian tubules of *Melanotus communis* are similar to those described by Henneguy (1904, page 80) for Malpighian tubule cells in general:

> "Les cellules épithéliales sont grosses, avec un noyau volumineux et des striés protoplasmiques dans la partie de la cellule tournée vers la luminère du tube, rappellant les cellules rénales des Vertébrés supérieurs."

In other insect tubules, cells that are striated on the side toward the lumen are also reported by Breakey (1936), Henson (1931), Imms (1924), Ishimori (1924), Stuart (1935), and Wigglesworth (1931). However, in a great number of insects this distal edge bears a chitinous intima which has not been found in *Melanotus communis*. Such an intima, either explicitly called chitinous or implied to be such, is reported by Branch (1922), Lewis (1926), Snodgrass (1925), and Swingle (1930). A chitinous lining may be present for only a part or for the entire length of a tubule and is usually found in them when they arise from the hind-intestine (Henson, 1931, 1932, Marshall, 1927).

Other structures have been reported present in the tubules of insects which are absent in *Melanotus communis*. The basal striations mentioned by Imms (1924) as found in many insects, by Marshall (1927) in ephemerids, and by Wigglesworth in *Rhodinus* (1931) were not found. Nor were any muscle fibers seen, such as Eastham (1925) and Pantel (1914) reported for various Diptera.

A wide variety in the mode of terminations occurs among Malpighian tubules of different insects. The tubules may end independently of

each other, being held to some other organ by a muscle (Eastham, 1925), or by a trachea (Lewis, 1926). In some cases the tubules are free for a distance in the haemocoele and then terminate on the wall of the rectal region where they may or may not anastomose (Ishimori, 1924, Woods, 1916). In certain other insects conditions are more like those in *Melanotus communis*. In *Drosophila funebris* (Eastham, 1925) two of the four tubules form a complete loop with a continuous lumen. Bugnion (1920) states that the four tubules in the lampyrid beetles (closely related to the elaterids), form two complete loops, involving the glandular epithelium. Ishimori (1924) has demonstrated that the hepialid moths are exceptional among the Lepidoptera in having the six tubules unite distally into two groups of three each. The exact nature of the union is not discussed.

A mid-intestinal insertion of the Malpighian tubules in insects is common. However, because of the early and firmly established theory of their ectodermal origin, Mayet in 1896 and later Pantel in 1914 found it necessary to contest strongly for their own evidence of the endodermal insertion of the tubules. In 1932 Henson offered the following explanation for differences in origin of the tubules and one which appears to correlate the great variations of place of insertion and the presence of chitin in some cases and of a striated border in others. Henson believes that in the process of the formation of the gut the relation of the time of differentiation of the tubules to the progress of the invagination of the gut determines whether they enter the mid- or the hind-intestine. As Eastham (1930) indicated, the confusion arises largely from the definition of the germ layers and their derivatives in insects.

Because of the insertion of the tubules above the pyloric valve, and because of the presence of striated borders and the lack of chitinous intima in the tubule, the cells of the Malpighian tubules of *Melanotus communis* seem to be more nearly related to those of the mid-intestine than to the ectodermal cells of the hind-intestine.

SUMMARY

1. The four Malpighian tubules of *Melanotus communis* enter the mid-intestine singly and immediately anterior to the pyloric valve.

2. They are covered by a thin layer of peritoneal epithelium, called the sheath.

3. They unite in pairs at their distal tips. The union is made by peritoneal sheath cells, not by the glandular epithelium.

4. The cells lining the tubule are striated on the side bordering the lumen.

5. Two types of cells are found in the wall of the tubule: (a) small columnar ones near the insertion of the tubule and (b) large pyramidal ones extending from this region to the distal end of the tubule.

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EXPLANATION OF PLATE I

Fig. 1. View of left loop of tubules. Total length of loop about 40 mm. Fresh tissue in Ringer's solution.

Fig. 2. Cross section of distal region of tubule. Helly's fluid fixation stained in Mayer's hematoxylin and light green.

Fig. 3. Loosely formed connection between the distal tips of a pair of tubules. A bridge of peritoneal cells may be seen between the two tips, below, a trachea passes from one to the other. Osmic vapor fixation, stained in methyl green, whole mount.

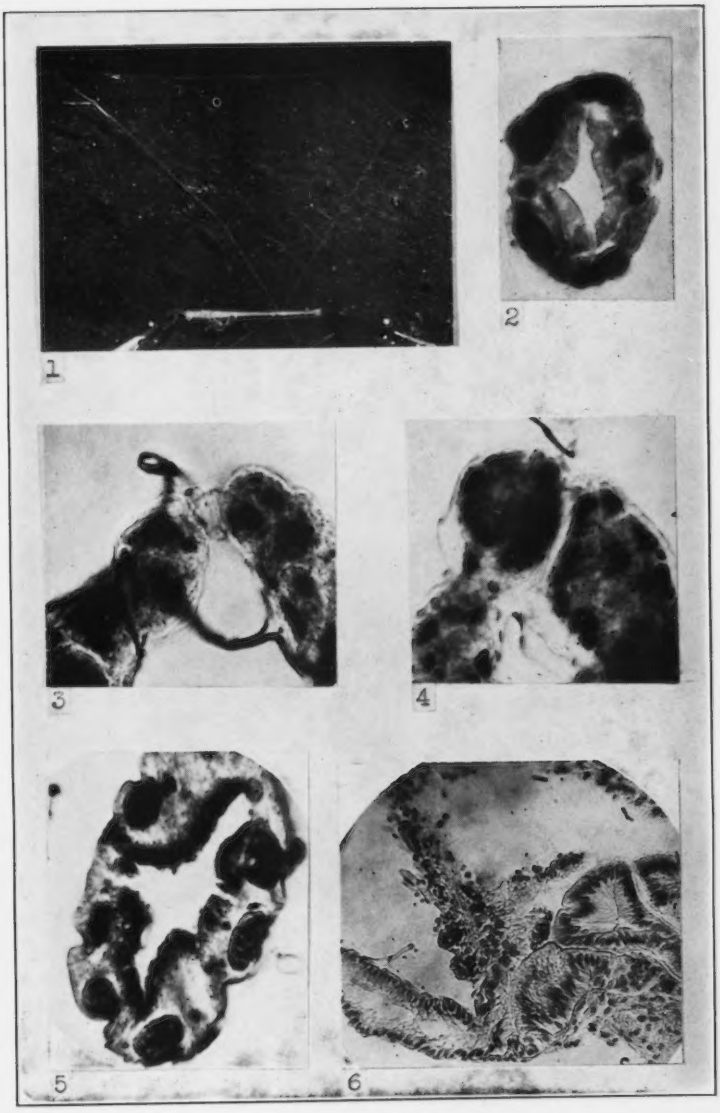
Fig. 4. Closely formed connection between the tips of a pair of tubules. Osmic vapor fixation, stained in methyl green, whole mount.

Fig. 5. Oblique section of distal region of tubule, fixed in Regaud's fluid, stained in iron hematoxylin.

Fig. 6. View of entrance of tubule. In the right hand lower quadrate are the pyloric folds, the mid-intestine is above, and to the left and below is seen the proximal region and insertion of a tubule. Note that 3 regenerative nidi are present on the mid-intestinal wall just above the entrance of the tubule. Helly's fluid fixation, stained in Mayer's hematoxylin and eosin.

Malpighian Tubules
Janet Wilder and Christianna Smith

PLATE I



A CONTRIBUTION TO THE LIFE HISTORY OF CHIMARRHA ALBOMACULATA KOLBE FROM PUERTO RICO (TRICHOPTERA: PHILOPOTAMIDAE)[1]

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During the months from April to September I was interested in collecting immature stages of Trichoptera in the mountain streams of the southwestern part of Puerto Rico. These streams are tributaries of the Mayaguez, Quanajibo, Flores, Yauco, and Arecibo Rivers. When the larvae and pupae were reared to the adult stage, the most abundant form proved to be *Chimarrha albomaculata* Kolbe, which was first described by H. J. Kolbe (1888). He based his description primarily on color. In spite of the abundance of this form there are no records concerning the immature stages of this colorful species.

DISTRIBUTION AND HABITS

The larvae and pupae were most plentifully found in the tributaries just above their confluence with the larger streams and rivers, where the current is relatively moderate in comparison to the swifter upper parts. At the lower altitudes the streams are wider, the stones somewhat more numerous, and often covered with algal growth, the food of the larvae. In the parts of the streams which are 2500 feet above sea level, *Chimarrha albomaculata* Kolbe practically disappeared, while other forms of Trichoptera became more abundant. Here the current is swift, the bottom solid rock, and there is much less plant life in the streams themselves.

The larvae may be seen occasionally crawling over the submerged rocks. They are usually under cover, under stones, especially where leaves have been caught and have been held for some time. On turning over a stone that has a surface of 25 to 100 square inches, one may find from 1 to 25 larvae crawling around, in all sizes from those that are almost microscopic to

[1]I wish to express my appreciation to Professor C. L. Metcalf for his direction and assistance.

[2]Contribution from the Entomological Laboratories of the University of Illinois, No. 190.

those ready to pupate and there may be from 1 to 10 pupal cases attached. The larvae start crawling as soon as disturbed, pulling themselves backwards by means of their prolegs to get to the other side of the stone or into crevices. Many times they are found under their nets which have collapsed. These nets are loosely constructed but catch a fine film of silt which may entirely cover the stone.

The pupae are well protected in their cases which are very similar to the cases of the Rhyacophilidae and Hydropsychidae as shown by Betten (1934). They are made of coarse gravel, pebbles, and small stones up to two inches long. This well cemented hood of pebbles is fastened securely to the rocks. The pupa is not only surrounded by this outer masonry of stones but inside by a complete cocoon besides a ventral wall, which is characteristic of the Hydropsyche case. This is in agreement with the observation of Betten (1934) in other Philopotamidae, while Müller states that there is no cocoon but only a ventral wall.

DESCRIPTIVE NOTES ON *Chimarrha albomaculata* KOLBE

Adult.—Body 4 to 5 mm. long. Wing expanse 14 to 15 mm. The color of the following parts is golden brown: the head, antennae, first and second segments of the maxillary palpi, labial palpi, thorax, prothoracic legs as far as last tarsal segment, meso- and metathoracic legs except tarsus. The other segments of the above appendages and the tibial spurs are a dark brown. The abdominal tergites are lighter in color on the caudal margin, elsewhere brown. The sternites are a lighter brown. The fore wing (Plate I, fig. 1) has 8 silver hairy spots, the rest of the wing being covered with black hairs. The hind wing is somewhat lighter and less hairy. The apical margins of both wings are fringed with white hairs, while the caudal margins of both wings are fringed with brown hairs. In the venation (Plate I, fig. 5) Sc is unbranched. M_4 is lacking in both fore and hind wings. There is one inner short spine on the fore tibiae, four spines on the meso- and metatibiae. For the genitalia of the male and female see Plate I, figs. 1, 3, and 4. The genitalia of the female was drawn from a mature pupa.

Pupa.—Male 7 mm. long, 1.5 mm. wide. Female 9 mm. long, 2 mm. wide. The changes in the pupal development are chiefly of color and compactness of body. The newly formed pupa is a lighter yellow with the exception of the fringe of brown hairs on the outer margin of the tarsus of the mesothoracic legs, while on the inner margin the fringe is white. The colors gradually changes to those of the adult. The mandibles are conspicuously long, flat and thin, with well developed serrate teeth (Plate II, fig. 8). The arrangement of setae on the head is as shown in Plate II, fig. 7, and on the rest of the body as in Plate II, figs. 10, 12, and 13. The hind legs usually reach to the end of the

abdomen. The antennae extend to the 5th sternite at least. Tergites of abdominal segments 3 to 8 inclusive have a pair of hooks on the cephalic margins. Segment 5 bears in addition, two groups of hooks, three in each group on the caudal margin. The hooks on the cephalic margin of segment 6 are also in two groups of three each. All hooks curve caudad with the exception of the hooks on the caudal margin of tergite 5. (Plate II, fig. 10.)

Larva.—Thysanuriform, 18 mm. long, 1.5 mm. wide. Golden yellow color. Head (Plate II, fig. 11) brown, dorsal aspect rectangular, lateral aspect wedge-shaped. Antennae double. Labrum greatly widened at cephalic end. Mandibles asymmetrical, two bristles on outer margin, inner surface without bristles. Lacinia (Plate II, fig. 9) of maxillae with two conspicuous tufts of hairs on the inner margins. Labium oval, palpi greatly reduced. Frons as shown in Plate II, fig. 11. Setal arrangement on head as in Plate II, fig. 11, on legs as in figs. 6 and 7. Lateral margin of occiput (Plate II, fig. 6) with small black spots. Prothorax chitinized, caudal margin collar-like and black, the rest brown. Coxal plates of each leg black. Abdominal segments uniform, arrangement of setae as in Plate II, figs. 6 and 7. Five blood gills on the 9th abdominal tergite. Anal prolegs long with well developed claws. The prothoracic coxae with well developed spines.

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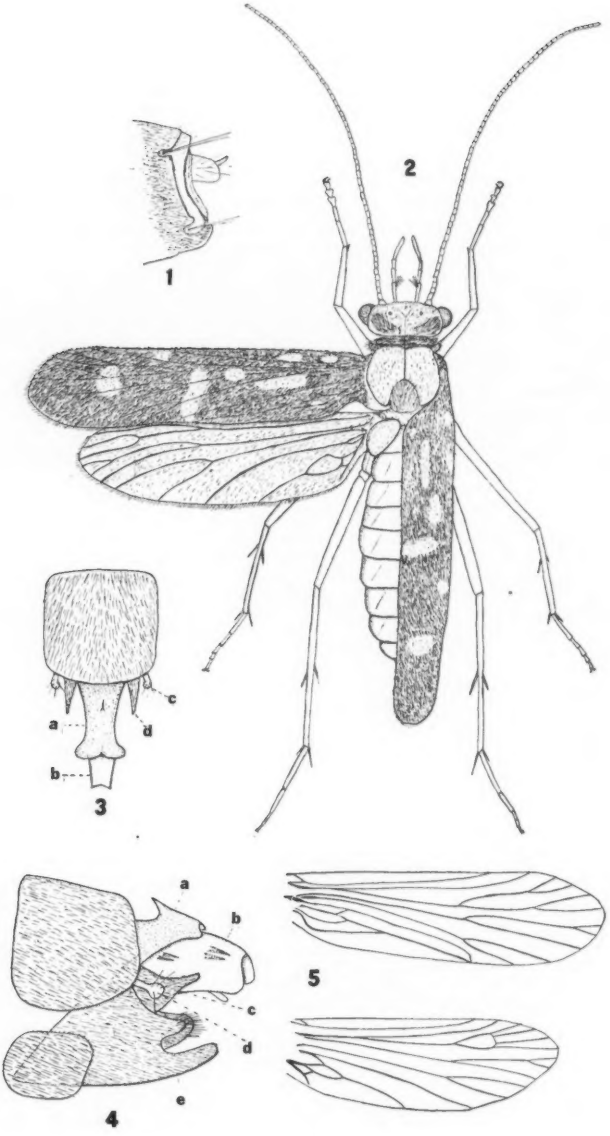
EXPLANATION OF PLATES

Plate I

Fig. 1. Lateral aspect of female genitalia, × 16. Fig. 2. Dorsal aspect of male, × 10. Fig. 3. Dorsal aspect of male genitalia, × 20. a. Tenth abdominal segment. b. Aedeagus. c. Pygopod. d. Clasper. e. Ninth abdominal segment. Fig. 4. Lateral aspect of male genitalia, × 20. Fig. 5. Fore and hind wings, × 10.

Plate II

Fig. 6. Lateral aspect of larva, × 5.5. Fig. 7. Dorsal aspect of larva, × 5.5. Fig. 8. Head of pupa, × 10.5. Fig. 9. Dorsal aspect of maxillae and labium, × 10.5. Fig. 10. Dorsal aspect of pupa, × 7. Fig. 11. Dorsal aspect of larval head, × 30. Fig. 12. Ventral aspect of pupa, × 6.5. Fig. 13. Lateral aspect of pupa, × 7.5.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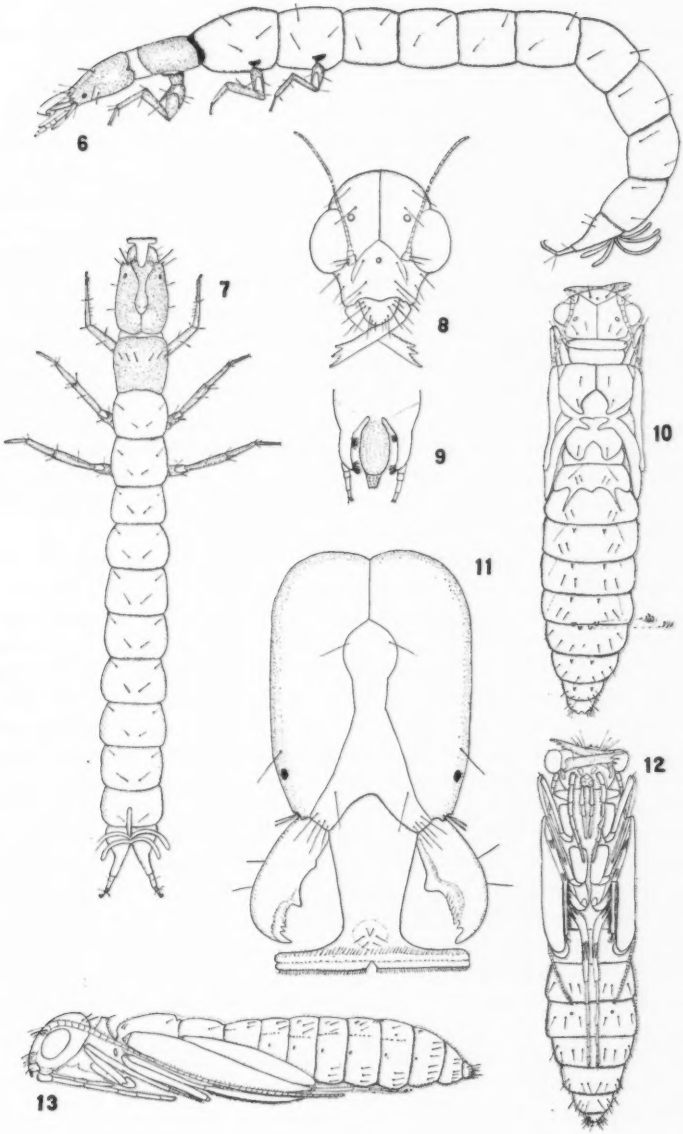
Chimarrha from Puerto Rico
Boyd B. Palmer

PLATE II



THE METAMORPHOSIS OF THE DIGESTIVE TRACT OF AEDES DORSALIS MEIGEN

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Members of the family Culicidae, because of their peculiar method of metamorphosis, are of great interest to the entomologist. The individuals within this group hatch from eggs, and the larvae, like those of all holometabolous insects, represent a post-embryonic life stage peculiarly specialized for feeding and growth. The larvae are aquatic and during warm weather may be found in shallow stagnant water in practically all localities. The pupae, in contrast with the corresponding stage in most other forms, are active—thus presumably protecting themselves from the numerous predators common to aquatic life. Despite their active existence and enormous energy requirements the pupae do not feed and should hence present many unique problems.

Numerous articles have been written demonstrating methods of metamorphosis in insects. Most papers have not, however, sufficiently considered the histological aspect of the problem, and very seldom, to the writer's knowledge, has notice been taken of the developmental relationships existing between various organs. If, when considering two or more organs, it should be found that one undergoes change into its imaginal condition while others remain typically larval until a later time, it is possible that the disintegrating larval tissue may influence the rate and direction of development of the imaginal tissue. Similarly, the developing imaginal tissue may influence the subsequent development of the larval tissue. The time factor of change in an organ undergoing metamorphosis might thus be of great importance. When such aspects of development are considered, insect metamorphosis may prove to be much more involved than formerly supposed.

Henneguy (1904, p. 531), discussing the pupal stage, men-

[1]The present paper is an abridgment of a thesis written at the University of Utah in partial fulfillment of the requirements for the degree of Master of Arts. The author wishes to express his indebtedness to Dr. R. V. Chamberlin, head of the Department of Zoology, to Drs. Don M. Rees, W. W. Newby and W. P. Cottam, who served on his graduate committee, and to Dr. D. T. Jones and other friends who aided and encouraged him.

tions several types of pupal development. He says that certain larval organs are partially or totally destroyed during pupation to be replaced by organs of new formation. Other organs, he states, are not found in the larva but develop entirely during the pupal stage. Still other of the larval organs disappear completely during pupation and are never replaced.

Thompson (1905) working with *Culex* states that the epithelium of the esophagus undergoes no disintegration but continues through into the imago perhaps with some cell multiplication. The epithelium of the midgut in *Culex* is sloughed and is replaced by a new epithelium derived from scattered "regenerative cells." The larval colon histolyzes and is replaced by a canal which grows into its lumen through proliferation from ileum and rectum. Prior to this growth, the epithelium of the ileum and of the rectum undergoes partial histolysis.

Needham (1897) found regeneration associated with feeding in the digestive epithelium of such insects as the dragonfly wherein is found the holocrine type of secretion and discontinuous taking of food. Haseman (1910) found an absence of epithelial regeneration in forms such as *Psychoda* where continuous taking of food and the merocrine type of secretion are the rule. Haseman, discussing the work of Möbusz (1897), states, "Möbusz studied the changes in the mid-intestinal epithelium of *Anthrenus* during the larval molts and found that the same changes appeared then as at pupation only less intensive."

Perez (1910) found the literature concerning metamorphosis contradictory. The stages of metamorphosis were not perfectly progressive but quite irregular and even irrational. He says that Ganin (1876) was the first investigator to notice the imaginal islands or regenerative nuclei at the base of the larval mid-intestinal epithelium. Various workers, according to Perez, have attributed erroneous functions to these cells. Breed (1903) thought that they aided in disintegration of the muscles and had a leucocytic function. Anglas (1898) had agreed with Breed but later (1904) stated that these cells not only disintegrated muscle but assisted in the renovation of the intestine. Perez says that these cells have nothing to do with the leucocytes nor with the tracheal system, as some earlier workers had supposed, but that they undoubtedly serve in building up the imaginal epithelium of the midgut.

MATERIAL AND METHODS

Material of *Aedes dorsalis* Meigen was taken from waters west of Salt Lake City. Larvae and pupae were collected and transported to the laboratory where the jars containing the specimens were unsealed and by means of a rubber band, gauze was fastened over the top. The specimens were then kept fairly warm, out of the direct sunlight, and in water from their original habitat. The larvae fed on algae and pupated in one to five days depending on the degree of maturity, temperature and other factors. The pupae, after about three days, usually emerged as adults, and the adults rested on the sides of the jars. Adults were anesthetized and identified under a binocular microscope preparatory to fixation. Specimens of larvae and pupae were also identified, removed and fixed at various intervals during their development.

Mature adults collected by means of a sweep net from the damp grasses near their breeding places were brought alive to the laboratory and before fixation were etherized for identification.

For this study it was necessary to use serial sections almost exclusively. A complete series of such serials was prepared, and all sections were treated identically, insofar as was possible, to eliminate variables due to the factors of technique. This set of slides supplied the working basis for the investigation but was supplemented by sections fixed and stained in various ways.

The paraffin method of preparing slides was most serviceable. Bouin's and Gilson's fluids were excellent for fixing adults but Carnoy's and Carnoy and Le Brun's fluids gave best results with larvae and pupae—the latter being used exclusively for the serial sections. Chloroform, since it renders the exoskeleton less brittle, was used as a clearing agent. The serial sections were cut at ten microns and were stained with Hanson's iron trioxyhaematein followed by picro-fuchsin. Iron trioxyhaematein may be prepared as follows:

Solution A.	Ferric ammonium alum, violet crystals	10 gm.
	Ammonium sulphate	1.4 gm.
	Distilled water	150. cc.
	Dissolve with gentle heat.	
Solution B.	Haematoxylin crystals	1.6 gm.
	Distilled water	75. cc.
	Dissolve with gentle heat.	

Cool each solution completely. Pour A into B in a porcelain dish stirring the mixture as it becomes first brown, then blue and finally dark violet. Heat slowly to boiling and allow to cool for thirty to sixty seconds while stirring but slightly in order not to accelerate oxidation from the air. Cool rapidly by floating the dish in cold water. The solution should be dark brown. A greenish tone shows that it has been too strongly oxidized. The mixture may be used immediately.

METAMORPHOSIS OF THE DIGESTIVE TRACT

In preparing a series of slides for the study of this problem, some method of designating the degree of development was necessary. Previously the time factor has been employed for this purpose. With variations of temperature, food and many other inconstant elements

the length of time necessary for development varies considerably (de Boissezon, 1930). In measuring the head capsules of the pupae, the author found that the rate of growth of this structure was not constant. Adequate results were secured, however, by employing the length of the ventral diverticulum of the esophagus as an indicator of age. The ventral diverticulum is an outpocketing of the esophagus extending along the gut. It is absent in the larva and has a length of about 3.37 mm. in the imago. The rate of growth of the diverticulum was not constant but it was found that the size intervals listed below represented approximately equal time intervals. In serial sections of known thickness, the length of the diverticulum is easily determined.

For this study the following standard has been adopted:

0.	Larva (immature)	3d instar.		
1.	Larva (mature)	4th instar.		
2.	Pupa No. 1	Ventral diverticulum absent		
3.	Pupa No. 2	"	"	90 microns
4.	Pupa No. 3	"	"	100 microns
5.	Pupa No. 4	"	"	110 microns
6.	Pupa No. 5	"	"	130 microns
7.	Pupa No. 6	"	"	170 microns
8.	Pupa No. 7	"	"	180 microns
9.	Pupa No. 8	"	"	540 microns
10.	Pupa No. 9	"	"	710 microns
11.	Pupa No. 10	"	"	1280 microns
12.	Imago (mature)	"	"	3370 microns

For convenience, each of the above stages will be hereafter denoted by employing the designation given in the second column.

Metamorphosis of the Esophagus.—In the mature larva, a section of the esophagus (fig. 1) appears as a highly flattened layer of epithelium with a prominent chitinous intima surrounded by a thick layer of striated muscle. While not highly folded, the epithelium and intima are quite irregular. Upon pupation the epithelium begins to thicken, and many mitotic figures are visible (figs. 2 to 7), increasing progressively in number until the seventh or eighth pupal stage when cell multiplication evidently ceases. During this development the flattened cells gradually assume a definitely columnar form (figs. 1 to 8). Simultaneously the muscular layer undergoes progressive degeneration until at about the same time as cessation of mitosis it practically disappears (fig. 8). From this point on, the spindle-shaped imaginal muscle is built up presumably from "myoblasts . . . derived from the nuclei of the larval muscles" (Thompson, 1905, p. 185). In pupa No. 9, the distal portions of the epithelial cells become somewhat irregular, forming leaf-like extensions into the lumen (fig. 9). These gradually flatten out to form the regular columnar type of epithelium to be found in the imago (fig. 12). The intima first appears in the ninth pupal stage and follows the contour of the epithelium during the later stages of development until in the adult it becomes smooth and thin.

Metamorphosis of the Esophageal Diverticula.—The esophageal diverticula are not found in the larva but are typically imaginal structures. Hence they do not appear until pupation is somewhat advanced. The ventral diverticulum may first be seen developing as

a simple outpocketing of the esophagus during the second pupal stage (fig. 13). The cell membranes are more plainly visible than in the esophagus itself, and the epithelium appears to be pseudostratified. The cells gradually assume a distinct columnar shape but the nuclei remain situated at various definite levels (figs. 14 to 17). This is the condition in pupa No. 7 (fig. 17). At this time an intima is seen but is not visible in the following stage. In pupae Nos. 8 and 9 (figs. 18 and 19), the ends of the cells seem to break off, leaving a flattened epithelium with small nuclei as in pupa No. 10 (fig. 20). The adult epithelium is even more flattened and is smooth with minute scanty nuclei (fig. 21).

The paired dorsal diverticula are formed in somewhat the same manner as the ventral diverticulum. However, they do not appear until the fifth stage of pupal development (fig. 15). At this time, the cells are large and polygonal in shape but in the following stage (fig. 16) they assume the columnar form. In pupa No. 8 (fig. 18) the epithelium begins the process observed in the ventral diverticulum, which leads to the typical flattened structure found in the adult. In the imago, the dorsal and ventral diverticula (fig. 21) are almost identical histologically. Here, in surface view, delicate striae or folds of the intima and numerous epithelial nuclei are present.

Metamorphosis of the Midgut.—The typical larval midgut (fig. 22) consists of an epithelium of large pavement cells with huge nuclei. This epithelium exhibits a conspicuous striated border and is situated on a definite basement membrane. No intima is present during any stage but within the lumen may be observed a peritrophic membrane. In the last larval instar (fig. 23) the epithelial cells split and move apart. The striated border becomes discontinuous and in places disappears. Just above the basement membrane between these cells small regenerative nuclei can be detected. By the time the first pupal stage has been reached (fig. 24), the old larval cells have been pushed completely away from the basement membrane and are succeeded by regenerating epithelium developed from these nuclei. According to Haseman (1910) working with *Psychoda alternata* Say, these nuclei undergo direct cell division. In subsequent stages (figs. 25 to 30) the remnants of the old larval epithelium may be seen only as an amorphous mass lying in the lumen. The cell membranes of the new epithelium are not visible until a later stage. The nuclei gradually become more numerous in the following stages, probably by a process of mitosis (although cell division was not demonstrated), until in pupa No. 7 (fig. 30) cell membranes are again visible, and an epithelium of cells taller than broad but with rounded ends is seen. In pupa No. 8 (fig. 31) the epithelium is short columnar with nuclei at irregular levels, and the rounded ends of the cells are beginning to level off. In this stage also, the striated border last seen in the larva reappears and continues through to persist in the adult. In pupa No. 10 (fig. 33), the nuclei of the epithelium have assumed a definite central position within the cells, and the distal ends of the cells are perfectly flat. The only evident change noticed upon examining the adult (fig. 34) is a further development of the muscularis. The muscle layer of the midgut is at no time

very prominent. In the adult, muscle consists mostly of longitudinal bundles although some circular fibers are present (fig. 34).

The above description applies to the middle portion of the midgut wherein development proceeds most rapidly. The same processes occur along the remainder of the tube except that changes take place at a slightly later period. The cardiac caeca, a ring of eight outpocketings from the cardia or anterior portion of the midgut, are typically larval structures which have practically disintegrated in the first pupal stage and are missing entirely in pupa No. 2. After this stage they do not reappear.

Metamorphosis of the Ileum.—The epithelium of the ileum of the mature larva (fig. 35) is highly flattened, and the structure is difficult to make out. Nuclei are small and very scarce, and cell membranes are not evident. The muscle layer is very prominent, and the intima is visible. In the first pupal stage (fig. 36) the epithelium thickens, and nuclei are more noticeable. In the stage immediately following (fig. 37) the epithelium becomes columnar and continues so through pupae Nos. 3 and 4 (figs. 38 and 39). In these stages vacuoles appear and become increasingly more numerous until in pupae Nos. 5 and 6 (fig. 40) most cells of the epithelium are highly degenerate and are beginning to disappear. In pupa No. 7 (fig. 41) the epithelium is again definitely columnar and seemingly newly formed. The region is now termed the ileo-colon as the old regions of ileum and colon are now identical due to replacement of the colon cells by proliferations of cells from the ileum and the rectum. According to Thompson (1905, p. 190), ". . . in the metamorphosis of the ileum and rectum certain of the epithelial cells are eliminated and new cells, derived from epithelium which escapes destruction, replace them." The muscle layer continues throughout but becomes progressively smaller in each stage.

Metamorphosis of the Colon.—The epithelium of the colon in the mature larva (fig. 35) is composed of extremely large cells with enormous nuclei. A light staining border is present but cannot be compared with the striated border of the midgut since it is not so definitely set apart. It is slightly striated but the striations seem to continue down into the dark staining portions of the cells. In pupa No. 1 (fig. 36) the cells begin to break apart, and the muscle layer of the tract becomes more prominent. During the subsequent stages (figs. 37 to 40) up to the seventh pupal stage (fig. 41), in which these cells have entirely disintegrated and disappeared, the cells of the colon epithelium become progressively more and more structureless, seemingly by crumbling into small cytoplasmic granules, until finally they are replaced entirely by proliferations of cells from the regions of the ileum and the rectum. During this process of disintegration the nuclei of the cells become progressively smaller but remain intact until just before final dissolution of the cytoplasm. A prominent muscularis is present at all times.

Metamorphosis of the Ileo-colon.—After the disappearance of the colon, the term ileo-colon is applied to the region of the hindgut extending from midgut to rectum. This region first comes into existence in pupa No. 7 (fig. 41). Here, the epithelium is columnar, and the muscle

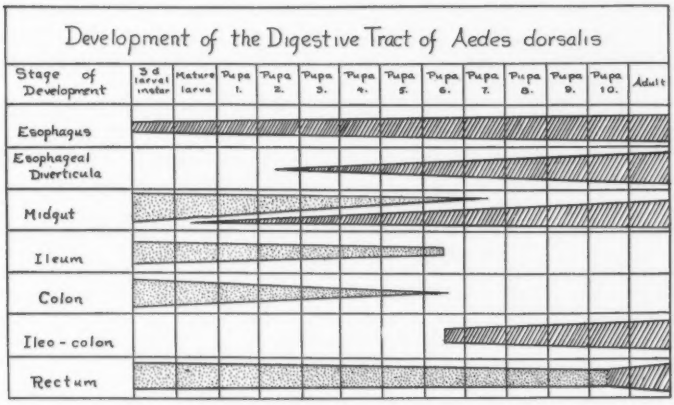
layer is prominent. In pupa No. 8 (fig. 42) the epithelium begins to flatten and to fold. At this point the muscle disintegrates. In pupa No. 9 (fig. 43) the epithelial layer is still more highly folded, and a muscularis of striated muscle is plainly evident. In the last pupal stage (fig. 44) and in the adult (fig. 45) the intima again becomes visible. The imaginal ileo-colon is composed of rounded polygonal cells folded in serpentine fashion and enclosed in a cylindrical tube of striated muscle. In the mature pupa and in the adult there is a short region at the anterior end of the ileo-colon which differs slightly from the remainder of the tract (figs. 44 and 45). Here the intima instead of being smooth as in the remaining portion is provided with rough spines projecting caudad into the lumen. In the adult the epithelium is not folded in this region nor are cell boundaries easily seen. The fundamental structure, however, of this and the remaining region of the ileo-colon seems to be the same.

Metamorphosis of the Rectum and Anal Ring.—The rectum of the mature larva (fig. 46) resembles the ileum to a great extent. The epithelium is flattened and wrinkled, and the intima is easily visible. These two layers are surrounded by a "capsule-like" layer of striated muscle. In pupa No. 1 (fig. 47) this layer thickens, and mitotic figures become visible. The cell boundaries are now easily seen, and the intima has completely disappeared. Rectal papillae first appear in pupa No. 2 (fig. 48). They are formed by multiplication and thickening of cells. Mitotic figures are visible, becoming progressively more abundant (figs. 49 and 50) until in pupa No. 5 (fig. 51) when they are no longer seen. At this stage the thickened cells of the papillae seem to split apart from the base upward but do not part at the apices. In the following stage (fig. 52) the cells evaginate remaining attached at the apices and folding outward to form an elongate papilla. In subsequent stages, the cells reunite along the lines of separation to form the typical outfoldings seen in the last three pupal stages (figs. 53, 54, and 55). In these three stages a chitinous intima is plainly visible. The papillae of the adult (fig. 56) have roughened edges and lose the distinct cell membranes seen in pupal papillae. The epithelium proper of the rectum consists of a thin layer of cuboidal or pavement cells some of which seem to disintegrate and to be cast off into the lumen in pupal Stages Nos. 8, 9, and 10 (figs. 53, 54, and 55). The remaining epithelial cells then develop into the typical flattened cells of the imago (fig. 56). The muscularis of the rectum, except at the anal region, seems to become almost negligible following pupal stage No. 5.

During the first pupal stage (fig. 47) there is formed at the anal end of the rectum, seemingly as a hypodermal ingrowth from the body wall of the anal region, a transient pupal structure known as the anal ring. In pupa No. 1 and in subsequent stages up to pupa No. 8, it is composed of dark staining columnar or cuboidal cells with a definite external muscularis. In pupa No. 8 (fig. 53) it loses its well defined cellular structure, and the distal portions of the cells begin to wrinkle. This is accentuated in the following stage (fig. 54), and in pupa No. 10 (fig. 55) the structure disappears and is not found in the imago.

Text figure No. 1 illustrates some very interesting time relationships concerning development in the various parts of the digestive tract. Beginning with the anterior end of the tract the esophageal epithelium is seen to continue through from larva to adult without substitution of new tissue. The esophageal diverticula, being derived from the esophagus, go through essentially the same process except that they do not make their initial appearance until a later time.

In the mid-portion of the tract the larval epithelium of the midgut and the epithelium of the imago overlap each other for about seven pupal stages, and during this time the latter replaces the former.



Text Fig. 1. Larval tissues are indicated in stipple, adult tissues by cross-hatching. Thickness of bar indicates the approximate degree of development of the tissue. Actual discontinuity of tissues is indicated only where the bar begins or terminates at a point. Some of the cells of the ileum, for example, continue as the ileo-colon which in part is composed also of elements from the rectum; hence the broad rather than pointed termination of the bar. The rectum itself shows partial histolysis, but the majority of the cells continue into the adult.

In the posterior end of the digestive tube the larval epithelium of the ileum and colon may be seen disappearing nearly simultaneously with the appearance of the epithelium of the adult ileo-colon. This transition is abrupt and is also true of the rectum as well. It must be remembered, however, that the break is not truly a definite one insofar as the epithelium of the ileo-colon and that of the imaginal rectum is produced not *de novo* but rather from active division of cells which have failed to disintegrate.

Further research considering a far greater number of structures may yield highly interesting and profitable facts concerning metamorphic relationships.

SUMMARY AND CONCLUSIONS

An attempt has been made to demonstrate the mode of pupal development found in the digestive tract of *Aedes dorsalis* Meigen, the most common mosquito of the Great Basin region. In this study five general methods have been determined by which larval tissues become, directly or otherwise, transformed into adult tissues. These are stated below in an ascending order of specialization:

1. Larval tissues continue into the adult without break but a multiplication of cells occurs in some instances. (Example: Esophagus.)

2. Some cells of the larval tissues disintegrate while others remain vigorous to divide mitotically and to replace the degenerating cells. (Examples: Ileum and Rectum.)

3. Larval tissue disintegrates entirely to be replaced by imaginal tissue developed from regenerative nuclei. (Example: Midgut.)

4. Larval tissue disappears and is not replaced except by invasion of cells from another region that form a new structure.(Example: Colon.)

5. Transient tissue found in neither larva nor adult may be built up temporarily in the pupa to disappear again before emergence of the imago. (Example: Anal ring.)

Type No. 1, above, is fundamentally the process observed during post-embryonic development in most animals. The last four types are seldom found outside the insect group.

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EXPLANATION OF PLATES

Plate I

Fig. 1. Esophagus of the mature larva.
Fig. 2. Esophagus of Pupa No. 1.
Fig. 3. Esophagus of Pupa No. 2.
Fig. 4. Esophagus of Pupa No. 3.
Fig. 5. Esophagus of Pupa No. 4.
Fig. 6. Esophagus of Pupa No. 5.
Fig. 7. Esophagus of Pupa No. 6.
Fig. 8. Esophagus of Pupa No. 7.
Fig. 9. Esophagus of Pupa No. 8.
Fig. 10. Esophagus of Pupa No. 9.
Fig. 11. Esophagus of Pupa No. 10.
Fig. 12. Esophagus of the Adult.
Fig. 13. Ventral esophageal diverticulum of Pupa No. 2.
Fig. 14. Ventral esophageal diverticulum of Pupa No. 4.
Fig. 15. Dorsal and ventral esophageal diverticula of Pupa No. 5.
Fig. 16. Esophageal diverticula of Pupa No. 6.
Fig. 17. Esophageal diverticula of Pupa No. 7.
Fig. 18. Esophageal diverticula of Pupa No. 8.
Fig. 19. Esophageal diverticula of Pupa No. 9.
Fig. 20. Esophageal diverticula of Pupa No. 10.
Fig. 21. Esophageal diverticula of the Adult.
Fig. 22. Midgut of the 3d instar larva.
Fig. 23. Midgut of the mature larva.

PLATE II

Fig. 24. Midgut of Pupa No. 1.
Fig. 25. Midgut of Pupa No. 2.
Fig. 26. Midgut of Pupa No. 3.
Fig. 27. Midgut of Pupa No. 4.
Fig. 28. Midgut of Pupa No. 5.
Fig. 29. Midgut of Pupa No. 6.
Fig. 30. Midgut of Pupa No. 7.
Fig. 31. Midgut of Pupa No. 8.
Fig. 32. Midgut of Pupa No. 9.
Fig. 33. Midgut of Pupa No. 10.
Fig. 34. Midgut of the Adult.
Fig. 35. Ileum and colon of the mature larva.
Fig. 36. Ileum and colon of Pupa No. 1.
Fig. 37. Ileum and colon of Pupa No. 2.
Fig. 38. Ileum and colon of Pupa No. 3.
Fig. 39. Ileum and colon of Pupa No. 4.
Fig. 40. Ileum and colon of Pupa No. 5.
Fig. 41. Ileo-colon of Pupa No. 7.
Fig. 42. Ileo-colon of Pupa No. 8.
Fig. 43. Ileo-colon of Pupa No. 9.

PLATE III

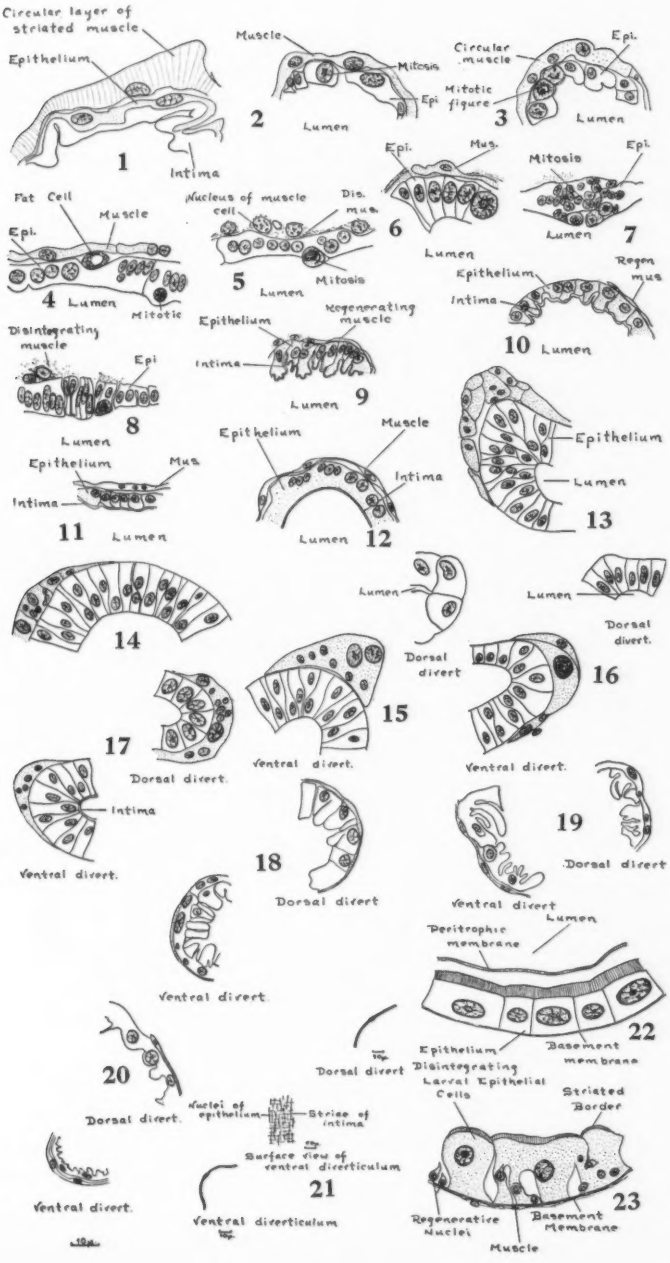
Fig. 44. Ileo-colon of Pupa No. 10.
Fig. 45. Ileo-colon of the Adult.
Fig. 46. Rectum of the mature larva.
Fig. 47. Rectum and anal ring of Pupa No. 1.
Fig. 48. Rectum and anal ring of Pupa No. 2.
Fig. 49. Rectum and anal ring of Pupa No. 3.
Fig. 50. Rectum and anal ring of Pupa No. 4.
Fig. 51. Rectum and anal ring of Pupa No. 5.
Fig. 52. Rectum and anal ring of Pupa No. 7.
Fig. 53. Rectum and anal ring of Pupa No. 8.
Fig. 54. Rectum and anal ring of Pupa No. 9.
Fig. 55. Rectum and anal ring of Pupa No. 10.
Fig. 56. Rectum and anal ring of the Adult.

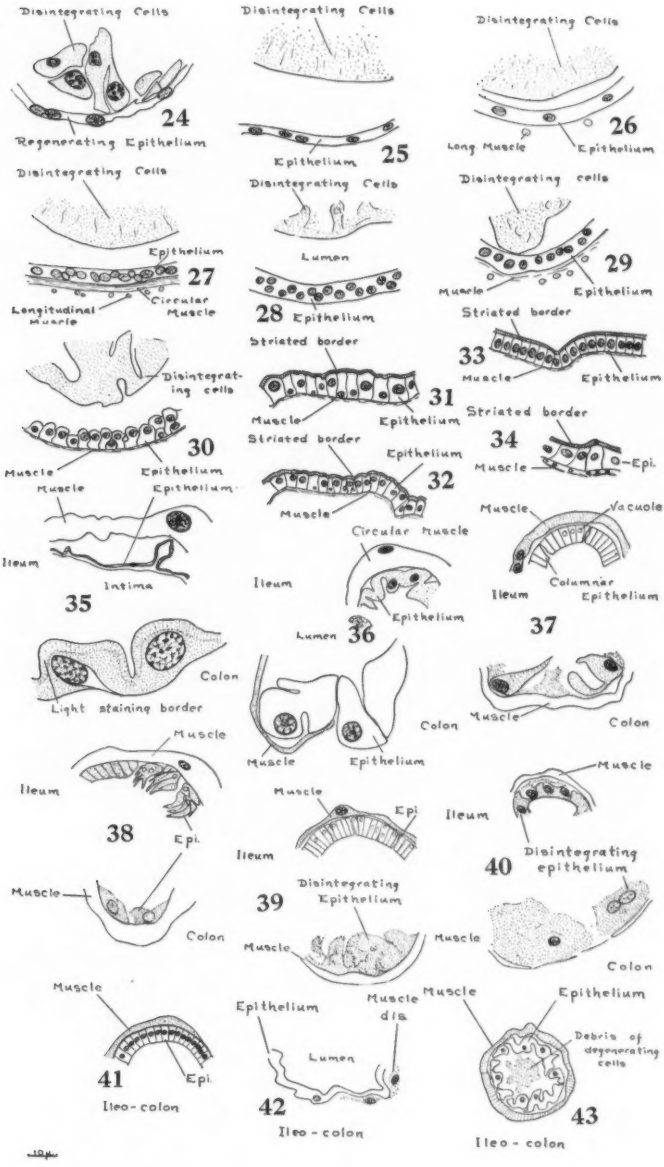
ABBREVIATIONS

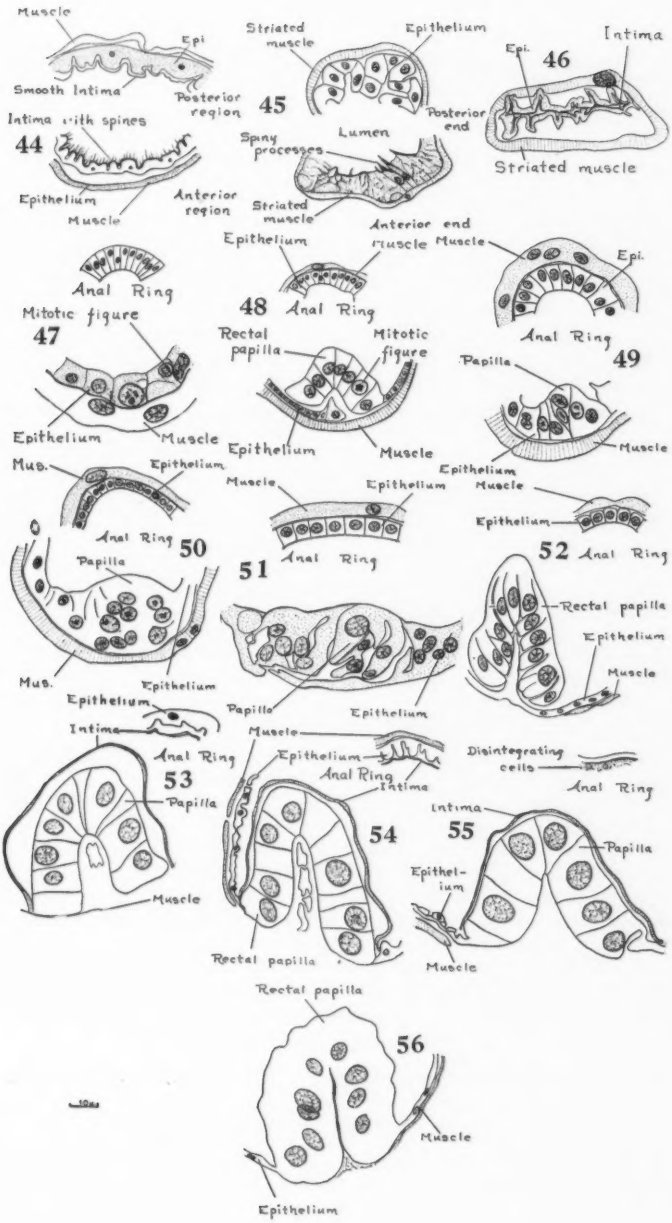
Dis. mus.—Disintegrating muscle.
Dorsal divert.—Dorsal diverticulum.
Epi.—Epithelium.
Long. muscle—Longitudinal muscle.
Mus.—Muscle.
Muscle dis.—Muscle disintegrating.
Regen. mus.—Regenerating muscle.
Ventral divert.—Ventral diverticulum.

Metamorphosis of Aedes
Calvin A. Richins

PLATE I




Disintegrating Cells
Regenerating Epithelium
24
Disintegrating Cells
Epithelium
25
Disintegrating Cells
Long Muscle
Epithelium
26
Disintegrating Cells
Epithelium
Longitudinal Muscle
Circular Muscle
27
Disintegrating Cells
Lumen
Epithelium
28
Disintegrating cells
Muscle
Epithelium
29
Striated border
Disintegrating cells
Muscle
Epithelium
30
Striated border
Muscle
Epithelium
31
Striated border
Muscle
Epithelium
33
Striated border
Muscle
Epi.
34
Muscle
Epithelium
Muscle
Ileum
Intima
35
Epithelium
Muscle
Ileum
32
Muscle
Vacuole
Circular Muscle
Ileum
Epithelium
Columnar Epithelium
36
37
Lumen
Colon
Light staining border
Muscle
Epithelium
Colon
Muscle
Colon
Muscle
Ileum
38
Muscle
Epi
Ileum
Muscle
Ileum
Epi.
Muscle
Colon
39
Disintegrating Epithelium
Muscle
Muscle
Disintegrating epithelium
40
Colon
Muscle
Epi.
Ileo-colon
Epithelium
Muscle dis.
Lumen
42
Ileo-colon
Muscle
Epithelium
Debris of degenerating cells
43
Ileo-colon


Muscle
Epi
Smooth Intima
Posterior region
Striated muscle
Epithelium
45
Posterior end
Intima
Epi.
46
Striated muscle
Intima with spines
44
Epithelium
Muscle
Anterior region
Spiny processes
Lumen
Striated muscle
Anterior end
Epithelium
Muscle
Muscle
Epi.
Anal Ring
48
Anal Ring
Anal Ring
Mitotic figure
47
Epithelium
Muscle
Rectal papilla
Mitotic figure
Epithelium
Muscle
Papilla
49
Muscle
Mus.
Epithelium
Anal Ring
Epithelium
Muscle
Epithelium
Muscle
Epithelium
Anal Ring
50
Papilla
Mus.
Epithelium
51
Anal Ring
52 Anal Ring
Rectal papilla
Epithelium
Muscle
Epithelium
Intima
Anal Ring
53
Papilla
Muscle
Papilla
Epithelium
Muscle
Epithelium
Anal Ring
Intima
54
Rectal papilla
Disintegrating cells
Anal Ring
Intima
55
Papilla
Epithel-ium
Muscle
Rectal papilla
56
Muscle
Epithelium

DESCRIPTIONS OF NEW LEPTOCERID TRICHOPTERA

HERBERT H. ROSS
Illinois State Natural History Survey, Urbana, Ill.

Each of the following new species resembles superficially some previously described one, but differs markedly in characteristics of the male genitalia. I wish to express my gratitude to Dr. C. O. Mohr, Illinois Natural History Survey, for assistance with the drawings. Holotypes are deposited in the Illinois Natural History Survey collection.

Leptocerus oxapius new species

Male.—Length 6.5 mm. Body, antennae and legs pale straw color, wings brown, eyes black. General structure typical for genus. Male genitalia, fig. 1, most closely resembling *vernalis* Banks, differing as follows: Tenth tergite divided into four processes, a long, lyrate lateral pair and a short, stubby mesal pair, fig. 1A, fused with ventral side of lateral processes, appearing as a linear patch of setae. Claspers extremely long. Oedagus V-shaped; from its expanded base a pair of sclerotized ribbons curve back and lie alongside apex.

Holotype, male—Ellerville, Okla., June 20, 1937, Standish and Kaiser.

Triaenodes phalacris new species

Male.—Length 11 mm. Body and appendages straw colored, eyes blackish, wings without definite pattern (this may be due to rubbing). General structure typical of subgenus *Triaenodes*. Genitalia, fig. 2, remarkably different from congeners as follows: Ninth segment produced ventrally into a tongue-like process set off from basal portion by a sharp ridge. Claspers with an ovoid base produced into finger-like, caudo-lateral process; dorsal portion produced into a large, irregular knob with scattered, stout setae. Sclerotized ribbons similar, each with a long, basal arm, thence curving back over apex of clasper. Apical portion of ninth sternite with an ental pair of filamentous processes fused at apex and forming a collar around opening of oedagus. Tenth tergite fusiform, angled to right of longitudinal axis. Cerci finger like. Oedagus ovate, with a ventral, spout-like process opening.

Holotype, male—Athens, Ohio, June 5, 1931, W. C. Stehr.

Triaenodes baris new species

Male.—Similar in size, color and general structure to the preceding. Genitalia, fig. 3, closest to *flavescens* Bks., differing as follows: Cerci

long, subequal in length to tenth tergite, the latter markedly fusiform, angled to the right of the longitudinal axis, extreme apex narrowed and pointed. Claspers short, the mesal, spicate lobe as long as and much stouter than lateral projection. Sclerotized ribbons as illustrated, alike in proportions, differing in details of sinuation. Oedagus typical for group, with base stalked and apex enlarged and divided into a dorsal and ventral lobe.

Holotype, male—Beach, Ill., June 10, 1933, Mohr and Townsend.

Triaenodes dipsia new species

Male.—Length 10 mm. Color and general structure as in the preceding. Genitalia, fig. 4, closest to *flavescens* Bks., differing as follows: Tenth tergite slightly fusiform, angled slightly to left of longitudinal axis. Cerci finger like. Claspers with stocky, robust base surmounted by a short, sharp lateral process and a mesal, broad lobe with brush of stout setae on its mesal and ventral margins. Expanded portion of sclerotized ribbons appressed to base of oeadgus, continuing as a narrow filament beyond apex of claspers. Left ribbon simple, right one with sharp tooth just beyond bend. Oedagus long, sharply angled in middle, apical portion divided into an upper and lower lobe.

Holotype, male—Athens, Ohio, May 28, 1932, W. C. Stehr.

Athripsodes uvalo new species

Male.—Length 8.5 mm. Body and appendages blackish brown, with antennae light brown, tarsi whitish, hind wings gray. Front wings with a scattering of black hair and white scales. General structure typical for genus. Genitalia, fig. 5, most similar to *punctatus* Bks., differing as follows: Cerci short and broad. Claspers with ventro-apical corner produced into a thumb-like process; sclerotized apical appendage curved and hook like. Tenth tergite with base semi-globular; apex long, concave beneath, shallow seen from the side and parallel sided as seen from above. Oedagus very similar to that of related species.

Female.—Similar in general color and size to male, but more robust. Diagnostic characters for females of this group are unknown.

Holotype, male—Athens, Pa., July 29, 1937, along Susquehanna R., J. H. Eddleston. *Allotype, female*—Same data.

Athripsodes saccus new species

Male.—Length 13 mm. Color of head and body black, flagella dark brown, tarsi whitish, hind wings very light brown and front wings with costal cell and a conspicuous area near apex of anal cells light brown, the remainder dark brown with the surface clothed with brownish hair and scattered, white scales. General structure typical for genus, and almost exact for *erraticus* Milne. Genitalia, fig. 7, differing remarkably

from *erraticus* Milne, fig. 6,[1] as follows: Cerci very short and stubby. Basal portion of claspers with a wide ventral expanse, widened towards apex which is surmounted by a brush of stout setae. Tenth tergite crescent shaped; dorsal portion forming a vertical plate enlarged at apex (seen from above), projecting above the cerci; ventral portion produced into a pair of rounded lobes each bearing at its apex about seven long, heavy setae. Oedagus somewhat amorphous, with a dorsal pair of long, sinuate filaments.

Holotype, male—Gibraltar Island, Put-In-Bay, Ohio, June 15, 1937, DeLong and Smith. *Paratypes*—Same data but June 2–8, 26, 27; 194 ♂. Deposited with the holotype and in the Ohio State University collection.

Athripsodes erullus new species

Male.—Similar in size, color and general structure to the preceding, differing in the eyes being reddish with a dorsal width greater than half the distance separating them, and in the male genitalia, fig. 8. Cerci longer and narrowed. Basal portion of clasper widest, inner margin plate like and apico-mesal angle bearing a sabre-shaped, sclerotized blade. Sclerotized process of clasper flattened and abruptly curved at extreme apex. Tenth tergite saddle shaped, the apical portion constricted just before apex, the apex with sharp corners and a meso-dorsal hump. Oedagus with ventral ligula stouter.

Holotype, male—Gibraltar Island, Put-In-Bay, Ohio, June 2, 1937, D. M. DeLong. *Paratypes*—Same data but June 2–8; 87 ♂. Deposited with the holotype and in the Ohio State University collection.

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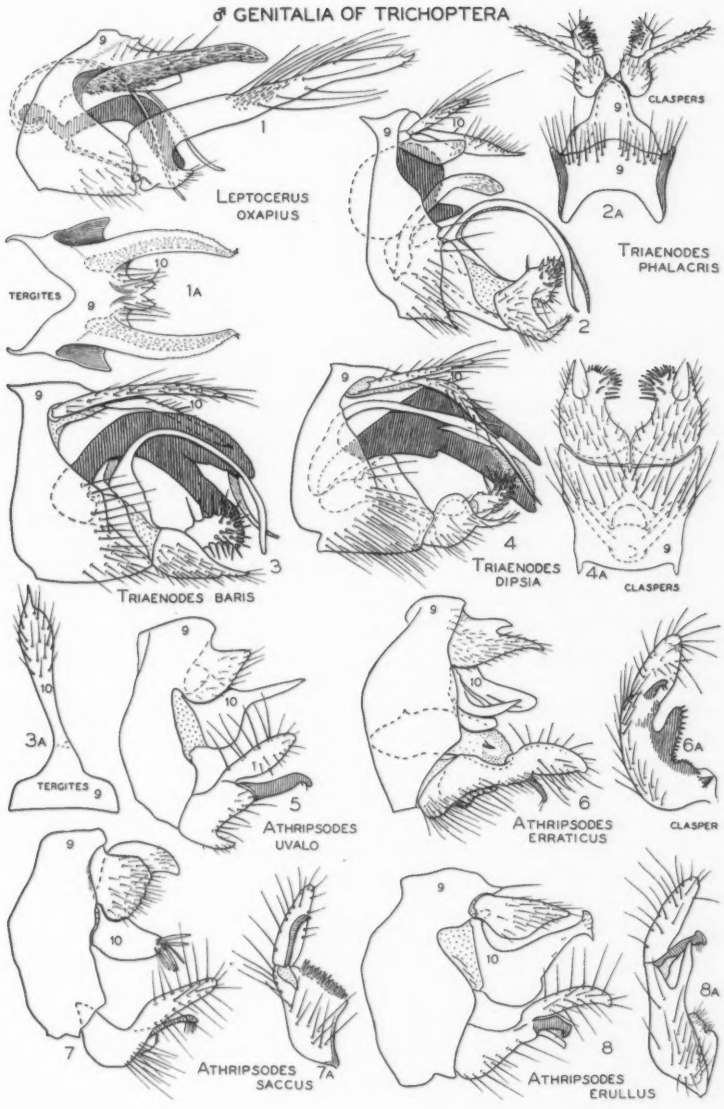
[1]Drawn from a paratype.


♂ GENITALIA OF TRICHOPTERA
LEPTOCERUS OXAPIUS
CLASPERS
TRIAENODES PHALACRIS
TERGITES
TRIAENODES BARIS
TRIAENODES DIPSIA
CLASPERS
TERGITES
ATHRIPSODES UVALO
ATHRIPSODES ERRATICUS
CLASPER
ATHRIPSODES SACCUS
ATHRIPSODES ERULLUS

THE EMBRYOLOGY OF THE CENTRAL NERVOUS SYSTEM OF PHORMIA REGINA, MEIGEN (DIPTERA: CALLIPHORIDAE)

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Ohio State University, Columbus, Ohio

The maggot of the Black Blow-fly (*Phormia regina* Meigen) has already been of value in the treatment of Osteomyelitis and infected wounds (Robinson 1933). Therefore information concerning the embryology of the nervous system should be of interest.

In the course of this study more than five hundred embryos were embedded, sectioned, mounted on slides, stained by various techniques and studied under several magnifications.[1]

In approaching the embryology of the nervous system the author was conversant with the more modern conception of Dipteran embryology, viz., that embryological development does not end with eclosion from the egg. Snodgrass (1935) and others have shown that much adult tissue develops from embryonic tissue in the imaginal discs during the pupal stage. The writer does not disagree with this view, but as a matter of expediency, "embryological development" is confined to the period between fertilization and eclosion from the egg membranes. The author's view is in agreement with the older conception of embryology advocated by Graber, Weismann, Escherich and other embryologists of the nineteenth century.

The history of dipterous embryology begins with Kolliker's observations on developing fly eggs, published in 1843, but the embryological record of the dipterous nervous system does not begin until 1858 when Leuckart's paper on *Melophagus ovinus*, appeared. Leuckart described the nervous system as seen through the transparent egg membranes, giving two figures.

[1]The writer wishes to acknowledge, with deep appreciation, the advice and criticisms of Dr. C. H. Kennedy, who directed the study. The aid of the author's wife in matters of routine was invaluable. The co-operation of Dr. D. F. Miller made an abundance of material available. Dr. Mary Auten generously allowed the use of slides showing the development of the germ layers. Many helpful suggestions of associates which aided in the solution of problems in method and technique were gratefully received.

Weismann (1863) makes note of the nerve cord formation in *Musca* but fails to include any figures dealing with that phase of the embryology.

Graber (1889) gives the first really useful data on the formation of the dipterous nervous system. Observations on the eggs of Calliphora and Lucilia species are supplemented by excellent drawings made from actual longitudinal and transverse sections of the eggs. Voeltzkow in his paper of the same year includes a short discussion and a few figures of the nervous system of *Musca vomitoria*. Lowne, in his two-volume work on the Blow-Fly (1893–95), devotes five pages to the embryology of the nervous system, including one text figure, but seems to have overlooked the work of Voeltzkow and Graber.

Escherich (1902) made important contributions to the data concerning the development of the nervous system, by his studies on the formation of the "Mittelstrang" in *Lucilia caesar*. For a period of thirty-one years further references to the development of the dipterous nervous system are lacking. Gambrell (1933) in her paper on the embryology of *Simulium pictipes*, makes note of the nerve cord development and includes several figures which show stages in development of the nervous system.

Much has been done in embryological research on other than dipterous insects which must not be overlooked: Mecznikow (1866); Bütschli (1870); Heider (1889); Cholodkowsky (1891); Viallanes (1891); Strindberg (1913); Nelson (1915); Hanström (1928); and Snodgrass (1935) are outstanding examples of this work. Many others might also be noted and are included in the Bibliography of this paper.

METHODS AND TECHNIQUE

Eggs of *Phormia regina* were obtained from stock cultures kept in a small, well-lighted room, in which the normal temperature variation was but a few degrees above or below 80° F. During any collecting period the temperature was maintained between 79° and 81° F. Eggs were taken only from normally developed flies four to five days after they had emerged from the pupae. Mr. A. C. Miller, of Ohio State University, has determined that, in well-fed cultures, the peak of egg fertility lies between four and five days, as well as the peak in egg-laying.

If there is no meat in the cages, the eggs of *Phormia* may be retained within the body several hours after fertilization. Under such conditions the newly laid eggs may contain embryos, well along in their development. In order to prevent this retention of eggs and to insure, as nearly as possible, accurate developmental records, lean beefsteak, upon which the flies readily oviposit, was placed in the cages and

allowed to remain for at least twelve hours previous to the collecting period. It was assumed that eggs obtained succeeding this twelve-hour period would have been fertilized just prior to oviposition.

In making collections of eggs, pieces of fresh, lean beefsteak were placed in the cages and examined carefully at 30-minute intervals. Any eggs deposited during a given interval were carefully removed to moist filter paper in a petri plate by means of a camel's hair brush. Different egg-masses were assumed to be deposited by different individuals and were kept segregated. The eggs were allowed to develop in the petri plates at room temperature, 80° F., samples from a given mass of eggs were fixed at 15-minute intervals from 3¾ to 6 hours. After 6 hours, fixations were made at 30-minute intervals until hatching, which occurred at approximately 10½ hours after oviposition.

The fixative used was that of Perenyi; a chromic acid, nitric acid and alcohol mixture (Perenyi, 1882). Stages from 6-hours up were also fixed in Kahle's fluid for purposes of comparison. Kahle's was not used for the early stages due to the statement of Cajal (Lee, 1928, art. 1056, p. 568), "For the study of the evolution of neuroblasts and nerve fibres in *very early embryos* it is necessary to avoid fixing with formol, or alcohol with an accelerator, or ammoniacal liquids."

Eggs were killed in distilled water 70°-75° C. The chorion was pricked (Gambrell, 1933, p. 643) to facilitate the entry of the fixing fluid, and the eggs placed in Perenyi's fluid for 2-3 hours. Excess fixative was removed by changing to 70% alcohol (12-15 hours), 95% alcohol (3-3½ hours), absolute alcohol (1-1¼ hours). From this point the eggs may be embedded or returned to 70% alcohol for storage. Recent developments in the use of dioxan and further experiments of the author indicate that the excess fixative could be removed to better advantage by using dioxan (Guyer, 1936) in place of the higher alcohols. The higher alcohols have a tendency to make the yolk hard and brittle whereas the dioxan seems to render the yolk tough and elastic.

A shorter method of embedding has been developed by the author. The chorion of the egg is removed using Gambrell's (Kennedy, 1932) method. The process of dechorionation is somewhat difficult at first due to the size of the eggs (approximately 1 mm. long, ¼ mm. in diameter), but a little practice renders the task easy. After dechorionation the eggs are stained, in order that they may be readily visible in the block. For in toto staining good results are obtained by using a 50-50 mixture of methylene blue (a saturated solution in 95% alcohol) and dioxan. The eggs remain in the stain 1-2 hours after which they are removed to dioxan for clearing (3-4 hours). Should the dioxan prove unsatisfactory as a clearing agent, clove oil, terpineol, cedar oil or xylene may be used; all of these are readily miscible with dioxan. When material is cleared, an equal (approximate) quantity of the embedding mass (melted) is added and the eggs placed in the embedding oven. The process preceding embedding may well be carried on in a Syracuse watch glass. Good results have been obtained by the writer with a Columbia Oven. The eggs remain in the oven until the dioxan has evaporated and infiltration of the embedding mass has occurred (the writer usually allows the material at this stage to remain in the

oven over night). This is followed by one change of the embedding mass (1–2 hours) after which the eggs are embedded. Paper boats proved very satisfactory if cooled in ordinary "cold" faucet water rather than "ice-water." The embedding mass used was "parowax," a mixture of commercial paraffin and 8% bayberry wax.

Embryos were cut on a rotary microtome, sections being 7 and 10 microns thick. Both longitudinal and transverse sections were made from each stage.

Various staining techniques were used, several of which gave very satisfactory results. Mallory's triple technique (Sharp, 1914), Heidenhain's Iron Haematoxylin, Alum Cochineal and Lyons Blue, Ehrlich's acid Haematoxylin and aqueous Acid Fuchsin, and Thionin (Lauth's violet) all gave very satisfactory differentiation. Considerable time may be saved in any of the techniques employing an aqueous stain if in place of the alcohol series two steps of dioxan are substituted; concentrated dioxan and 50% dioxan. In fact the dioxan is more satisfactory than alcohol in Mallory's technique for the anilin blue is not washed out of the tissue by the dioxan as it is by the alcohols. In using a dioxan series it is well to include carbol-xylol preceding the xylene, in order to be sure of dehydration. "Hyrax" (Eimer and Amend, N. Y.) with a refractive index of approximately 1.8 makes a very satisfactory mounting medium.

Drawings may be conveniently made from the slides by using a projection-microscope drawing apparatus. Outlines are readily obtained in this manner and may then be filled in under the higher powers of the microscope.

THE VENTRAL NERVE CORD

Auten (1934) reported the early development of the egg of *Phormia regina*. Her observations on eggs which hatched 12–17 hours after fertilization placed the laying down of the mesoderm and closure of the gastular groove at from 2–4 hours after fertilization. The writer's observations, as noted under the section on technique, were made on eggs hatching from 10½–11 hours after fertilization, so that hour stages are but roughly comparable to those of Auten. However, the first suggestion of the developing nerve cord may be said to appear shortly after the completion of gastrulation.

Origin.—The elements from which the ventral nerve cord develops appear to be ectodermal in origin, but will be discussed under two heads, (a) the ventral nerve cord, (b) the "mittelstrang" or "median cord."

(a) In sections of 4-hour embryos, large spherical cells each with a relatively small granular nucleus (neuroblasts) are seen to be differentiating from the columnar ectoderm along the ventral median line (Pl. I, fig. 1, NB). The neuroblasts, having a large, clear cytoplasmic area, form in the ectodermal layer and migrate inward until they lie between the ectoderm and mesoderm. This process occurs along the entire length of the embryo on both sides of a shallow longitudinal invagination, the neural groove of Wheeler (1893). These neuroblasts which will eventually form the two strands (or rods, Pl. I, fig. 6) of the ventral nerve cord are in three or four rows on each side of the neural

groove, scattered when first formed (Pl. I, fig. 2) but at the 5-hour stage they have clumped together on each side, adjacent to the neural groove and have begun to divide (Pl. I, fig. 4). The actual change of ectodermal cells into neuroblasts has not been demonstrated by the writer, owing largely to the difficulty of finding stains which will differentiate changing embryonic tissues.

The term "neuroblast" as used in this paper refers to the large spheroidal cells (Pl. I, figs. 1, 2, 3, 4), which through successive divisions give rise to the ganglion cells. This usage is in accordance with Wheeler (1891) and Escherich (1902). Lowne, on the other hand, designated the whole embryonic nervous system by the term "neuroblast," even in its later stages.

Each neuroblast, through successive mitotic divisions gives rise to a column of smaller, more darkly staining cells, the "ganglion cells" (Wheeler, 1893), from which the definitive nerve cord actually develops. These columns of "ganglion cells," through the mutual pressure of their own growth, the growth of the mesoderm and that of the "median cord," are molded into two more or less cylindrical rods, (Pl. I, fig. 4), the ventral nerve cords.

(b) Between the 4- and 5-hour stages, at intervals along the invaginated bottom of the neural groove, another series of ectodermal cells proliferate, forming the anlage of a second element, the "median cord," whose development is closely associated with that of the ventral nerve cord in its early stages (Escherich, 1902).

Ganglia.—Eastham (1930) indicates that the ganglia are formed from the undifferentiated cord due to the mechanical pressure exerted by the segmentation of the ectoderm and mesoderm. It is possible that this is true in Phormia, for at the 4½-hour stage the two rods of ganglion cells, as yet unseparated from the outer hypodermal layer, extend approximately the entire length of the embryo (Pl. I, fig. 5, GC) and show no differentiation into ganglia.

Changes occurring between the 5-hour stage (Pl. I, fig. 4) and the 5½-hour stage (Pl. I, fig. 6) cause the rods of ganglion cells to separate from the underlying hypodermal layer, while at intervals along the median line the proliferating "median cord" cells join with the "ganglion cells" of either side producing at each junction between the two lateral cords a swelling which may now be called a ganglion (Pl. II, fig. 7). A longitudinal section at the 6-hour stage shows a series of eleven definite swellings (ganglia) in the cord. The most anterior swelling probably being the ganglion of the mandibular segment.

Neurilemma.—The separation of the nerve cord from the hypodermal layer is accompanied by the formation of a neurilemma, around the nerve cord (Pl. I, fig. 6, NL). This sheath is composed of very thin cells whose source is not apparent. Wheeler (1893) believes the neurilemma may possibly arise from the neuroblasts, though more probably from the cells of the interganglionic "median cord." The small slender cells of the "median cord" in the interganglionic area probably grow out from the "median cord" anlage, developed, as stated before, in the ganglionic region. Escherich designates in his figures both an "inner" and "outer" neurilemma (1902, fig. 18), but does

not discuss their origins. Eastham (1930) is doubtful as to the source of the neurilemma, but as did Wheeler, postulates its development from the neuroblasts. Bruce (1887) believed the neurilemma to be formed from migratory mesodermal cells, which conclusion is contradicted by Graber (1889), who believes Bruce to have identified incorrectly as migratory mesoderm the cells of the "median cord."

The fate of the large neuroblasts, from which the ganglionic cells have proliferated, is doubtful. Wheeler (1893) believes these large cells may simply disintegrate, while Escherich (1902) seems to think that they may themselves differentiate into "ganglion cells."

Commisures.—In 6½-hour embryos the ventral nerve cord has begun to show a "ladder-like" internal structure. Sections of 6½-hour embryos exhibit a lighter, longitudinal stripe near the dorsal surface of each of the two elements in the ventral cord, and two definite connecting areas between these two longitudinal stripes in each ganglion (Pl. II, fig. 9). These lighter areas were designated "Punktsubstanz" by Graber. My sections indicate that these areas are probably formed by the fibers growing out from the nerve cells (Pl. II, fig. 9). Some of these fibers eventually connect with the peripheral areas. At this stage, cells growing out from the cord, at the ganglia, are forming what may be termed neural trunks (Pl. II, fig. 10, NT), nerve-like processes as yet without nerve fibers.

Very fortunately a horizontal sagittal section through the ventral nerve cord was obtained, in which the relations between the two sides of the cord and the commissures in the ganglia are plainly visible (Pl. II, fig. 11).

CEPHALIZATION

Cephalization.—The very interesting phenomenon of cephalization in the nervous system is shown in the later embryonic stages. At 6½-hours the cord extends practically the entire length of the embryo (Pl. III, fig. 12). This condition continues up to 8-hours, when definite shortening of the cord begins. At 9½-hours the cord is much shorter, as seen in Pl. III, fig. 13, the actual cord being perhaps better shown in a horizontal sagittal section (Pl. III, fig. 14). The shortening continues through the 10-hour and 10½-hour stages (Pl. IV, figs. 15 and 16), at which time the length of the cord is approximately one-third its original length.

The mechanism of this shortening is not self-evident. Examination of Pl. IV, figs. 17 and 18, and Pl. V, fig. 19, shows an increase in diameter of the cord as it shortens. Though it is not demonstrable in the sections, this shortening must be accompanied by a lengthening of the nerves supplying the posterior portions of the embryo.

THE BRAIN

The brain of the embryonic fly, theoretically composed of three ganglia, is very little like the brain of the adult. There seems to be no segregation of the embryonic brain into proto-, deuto-, and tritocerebral segments, as Viallanes reports for the Mantis or Nelson for the Bee. Lowne (1893-95) indicates that there is a definite segmentation apparent

in the brain of Calliphora, even in the embryo. The neuroblasts appear more or less segmentally (Pl. V, fig. 20), (the exact number of segments in the brain is not apparent), but later when the ganglion cells have formed there is no evidence of segmentation (Pl. V, fig. 23). The absence of segmentation in the brain may possibly be due to either of two factors: the embryonic divisions may simply have dropped out in the evolution of cephalization or may be passed over too rapidly to show. It is probable that the division of the embryonic brain may develop later in the life history of the insect. The writer hopes to be able to study the larval nervous system in the near future where a greater differentiation may take place.

The inception of the brain seems to be very much the same as that of the cord, except in its position dorsal to the oesophagus. Large neuroblasts differentiate from the ectodermal layer in embryos of the 4-hour to 4½-hour stages (Pl. V, figs. 20 and 21). No evidence of a "dorsal median cord" as reported by Graber in Calliphora (1889), was found in Phormia. "Ganglion cells" of the brain may be produced in columns by the neuroblasts in the same manner as reported for the cord, in my material no sections were found which show this process.

By the 6½-hour stage the brain has taken definite form but is broadly continuous with the cord (Pl. V, fig. 23, and Pl. VI, fig. 24). The formation of the circumoesophageal connectives between the brain and ventral cord occur in much the same manner as that of the interganglionic connections of the cord. Figures 21 and 22 (Pl. V) show scattered neuroblasts in the region between the brain and cord from which the circumoesophageal connectives develop. A further similarity between the circumoesophageal connectives and the interganglionic connections of the cord is their approximately equal size. These connectives are not mere threads, but have considerable thickness, very nearly that of a separate strand of the ventral cord (Pl. VI, fig. 27).

No differentiation of the brain into definite segments appears up to the time of hatching. Figure 28 (Pl. VI) shows a section from a 9½-hour stage which is very similar to a section from the same level in a 10½-hour stage.

The "Punktsubstanz" areas of the brain, which are the commissures, appear as early as the 6½-hour stage (Pl. VI, fig. 24). That these commissures are connected with those of the circumoesophageal connectives is shown in Figure 26 (Pl. VI).

In its earlier stages the brain is located close to the anterior tip of the embryo (Pl. V, fig. 23) but with the general shortening of the cord, occurring between the 8- and 10-hour stages, the brain becomes located farther back (Figures 29 and 30, Pl. VII).

The nerves, which in the adult extend from the brain to various structures of the head, thorax and abdomen, are not discernible at this stage of development, but it is apparent that there are sufficient connections to allow locomotion in the newly hatched larva. The apparently undifferentiated structure of the brain at the time of hatching indicates considerable post-embryonic development. This conclusion is confirmed by the work of Lowne on Calliphora (1893-95), a closely related genus.

SUMMARY

The central nervous system develops as a unit, but for convenience the discussion is divided into two parts: (a) The Ventral Nerve Cord; (b) The Brain.

(a) *The Ventral Nerve Cord.* The ventral nerve cord originates from a double set of cells, composed of three or four rows of large spheroidal neuroblasts, which differentiate from the ectodermal layer on each side of the ventral median furrow or neural groove. These neuroblasts through successive divisions produce numerous ganglion cells which make up the definitive cord.

At the bottom of the invaginated neural groove, cells which form a median cord are proliferated at intervals. The growth of cells in the median cord unites the two separate portions of the ventral nerve cord at intervals along its entire length thus forming the ganglia. Growth of the median cord cells of the interganglionic area may produce a sheath, the neurilemma, about the nervous system. Or possibly the neurilemma is formed by the neuroblasts after the formation of the ganglion cells is completed. The author has no conclusions to offer regarding the origin of the neurilemma.

In a 6½-hour embryo, lighter staining areas, the commissures, appear between the two sides of the ganglia. Longitudinal stripes also appear in the interganglonic connectives. These lighter areas are due to the formation of fiber tracts which connect the various parts of the central nervous system to each other and to the organs of the body.

Between the 8-hour and 10½-hour states, a decided shortening of the ventral nerve cord occurs, resulting in a final size of approximately one third the original length.

As early as the 6½-hour stage nerves are seen to be growing out from the cord, but their connections with definite organs could not be demonstrated.

(b) *The Brain.* The development of the brain seems to be essentially the same as that of the ventral nerve cord, except that there is a lack of evidence for the formation of a dorsal median cord. Neuroblasts differentiate from the ectoderm on the dorsal side of the embryo in the first three or four segments. The exact number of segments in the brain of this species is not apparent. The neuroblasts appear to divide into ganglion cells in the same manner as in the ventral nerve cord, but as the

brain forms there is no evidence of segmentation other than the segmental arrangement of the neuroblasts.

The brain and ventral nerve cord form as a continuous unit, connected by the circumoesophageal connectives, which develop in the same manner and to approximately the same size as the interganglionic connectives of the ventral nerve cord.

The relative simplicity of the embryonic brain, as compared to the brain of the late larva or adult, indicates considerable post-embryonic development of the nervous system.

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EXPLANATION OF PLATES

Note: Average length of embryo 712 micra; diameter 208 micra. All figures from specific slides but all diagrammatic except Plate VIII.

Plate I

1. Transverse section through 4-hour embryo showing neuroblasts differentiating from the ectodermal layer. 2. Transverse section through 4-hour embryo, approximately 450 micra from anterior end, showing scattering of the early neuroblasts. 3. Transverse section through 4-hour embryo showing relation of the neuroblasts to the neural groove, and the formation of the median cord. 4. Transverse section through 5-hour embryo, approximately 300 micra from anterior end, showing clumping of the neuroblasts and the presence of the ganglion cells. 5. Longitudinal vertical section through 4½-hour embryo showing the extent of the ventral nerve cord. 6. Transverse section through 5½-hour embryo showing the separation of the ventral nerve cord from the hypodermal layer (body wall).

Plate II

7. Transverse section through 5½-hour embryo just anterior to that shown in Figure 6, showing the ganglion, median cord and developing cross commissures. 8. Longitudinal vertical section through 6-hour embryo which shows the ventral nerve cord. 9. Transverse section through the central portion of a 6½-hour embryo. The cross commissures in the ganglion are developing and the neural trunks are forming. 10. Transverse section through the central portion of a 7½-hour embryo. Note the ganglion cells, the fiber tract and the neural trunk. 11. Longitudinal section in a horizontal plane through an 8-hour embryo. Note the ganglia, the pair of cross commissures in each ganglion, the interganglionic connectives and the neural trunks. (Plate VIII shows a photomicrographic enlargement of the section from which this drawing was reconstructed.)

Plate III

12. Longitudinal vertical section through 6½-hour embryo showing the length of the ventral nerve cord. 13. Longitudinal vertical section through 9½-hour embryo showing the shortening of the ventral nerve cord. 14. Longitudinal section through 9½-hour embryo in a horizontal plane, this also shows the shortening of the ventral nerve cord in the process of cephalization.

Plate IV

15. Longitudinal vertical section at 10-hour stage showing further shortening of the ventral nerve cord in the process of cephalization. 16. Longitudinal vertical section at 10½-hour stage showing the extent of the ventral nerve cord after cephalization is complete. 17. Transverse section through 8-hour stage approxi-

mately midway of embryo. 18. Transverse section through 9½-hour embryo. Note the increase in the diameter of the ventral nerve cord concomitant with the process of cephalization.

PLATE V

19. Transverse section through 10½-hour embryo showing the great increase in the diameter of the ventral nerve cord between the 8-hour stage and this one. 20. Longitudinal vertical section through the anterior portion of 4-hour embryo, the brain- and cord-neuroblasts are shown. 21. Transverse section from 4-hour embryo in which are shown neuroblasts from which the brain develops. 22. Transverse section through the anterior end of 4½-hour embryo showing neuroblasts of the brain, circumoesophageal connectives and the ventral nerve cord. 23. Longitudinal vertical section through the anterior portion of a 6½-hour embryo, showing the brain and its connection with the ventral nerve cord.

PLATE VI

24. Transverse section through the anterior portion of 6½-hour embryo. 25. Transverse section through the anterior portion of 6½-hour embryo just caudad of the circumoesophageal connectives. 26. Transverse section through the brain and sub-oesophageal ganglion of 7½-hour embryo. 27. Longitudinal section in horizontal plane between the brain and ventral nerve cord showing the circumoesophageal connectives in cross-section. 28. Transverse section through brain and sub-oesophageal ganglion of 9½-hour embryo.

PLATE VII

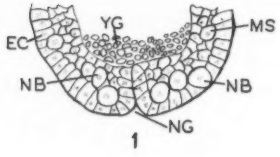
29. Longitudinal section in horizontal plane through the brain of 10-hour embryo showing fiber tracts from the circumoesophageal connectives. 30. Longitudinal vertical section through the anterior portion of 9½-hour embryo showing the relation of the brain to the ventral nerve cord.

PLATE VIII

31. A photomicrograph of a section from an 8-hour embryo, cut in a longitudinal horizontal plane. The body-wall is somewhat broken but the ventral nerve cord is intact and cross-commissures in four of the ganglia may be plainly seen as well as the fiber tracts in the interganglionic connectives. 32. A photomicrograph of a vertical longitudinal section from a 10-hour embryo, showing the central nervous system when cephalization is nearly complete, shortly before hatching. Compare with figures 8, 15, and 16.

SYMBOLS USED IN LABELING PLATES

BR.....Brain
BW.....Body wall
CC.....Circumoesophageal connective
CM.....Cross commissures
CN.....Interganglionic connectives
EC.....Ectodermal layer
FT.....Fiber tract
GC.....Ganglion cell
GN.....Ganglion
GT.....Gut
HY.....Hypodermal layer
MC.....Median cord (Mittelstrang)
MS.....Mesoderm
NB.....Neuroblast
HG.....Neural groove
NL.....Neurilemma
NT.....Neural trunk
OE.....Oesophagus
PR.....Proctodaeal invagination
SG.....Sub-oesophageal ganglion
ST.....Stomodaeal invagination
TR.....Trachea
VC.....Ventral nerve cord
YG.....Yolk granules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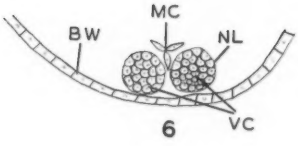
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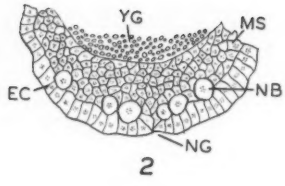
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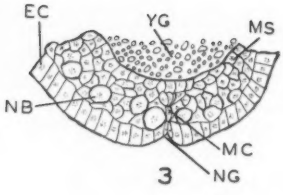
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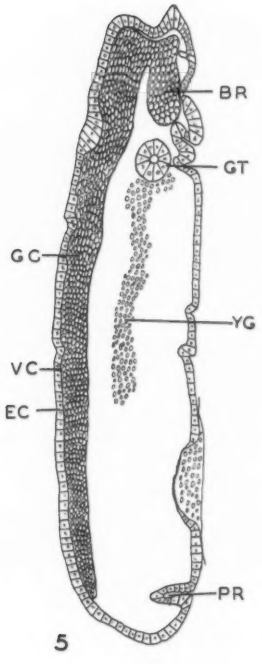
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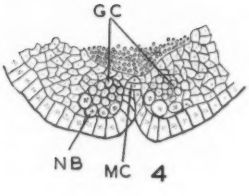
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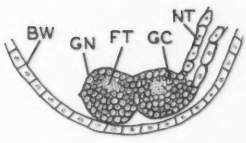
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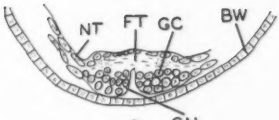
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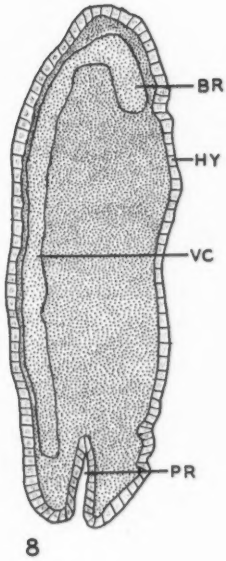
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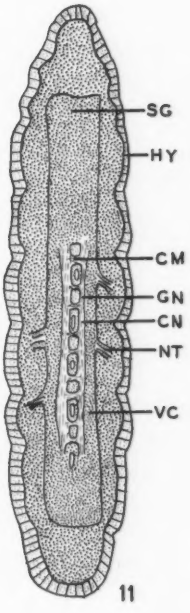
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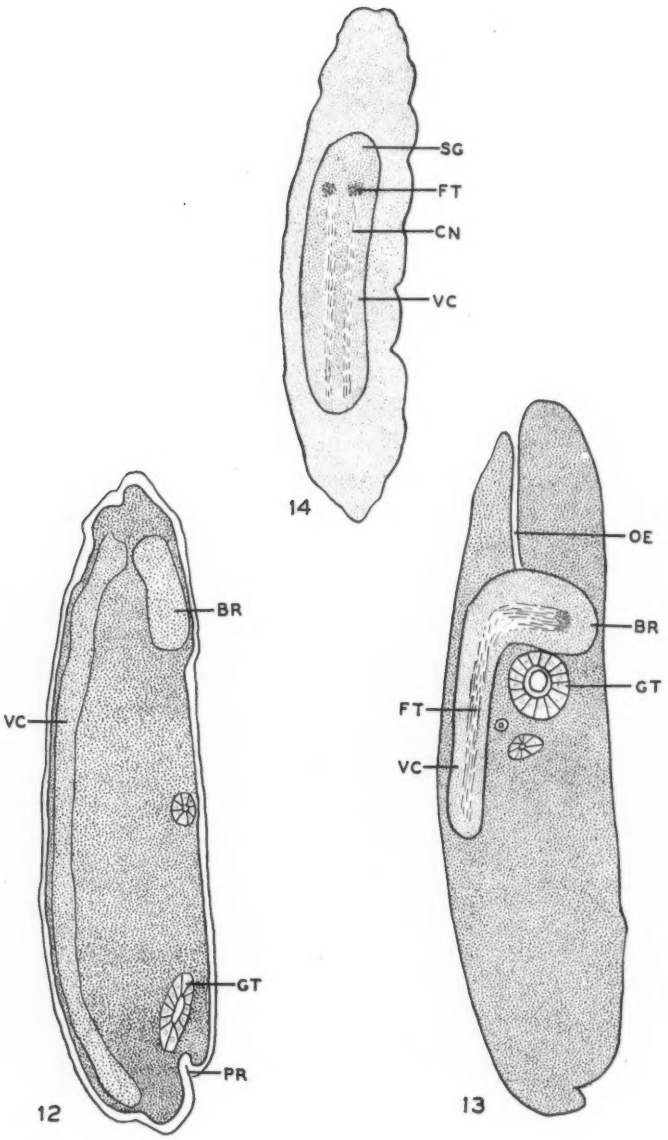
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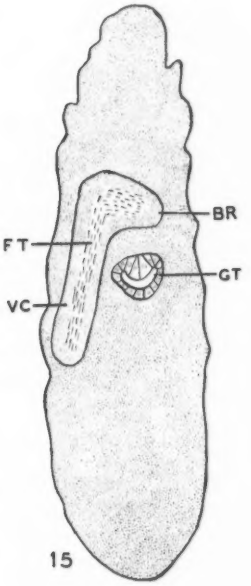

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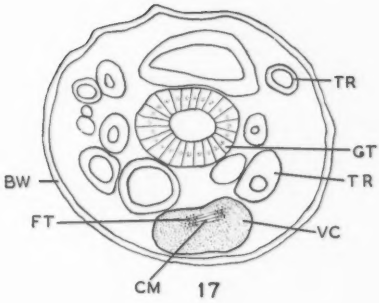

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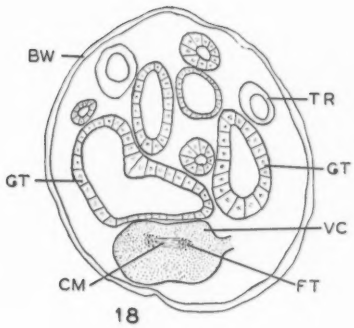

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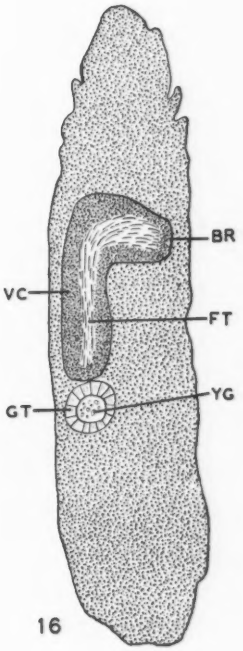

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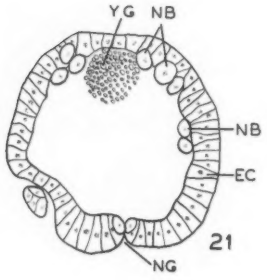
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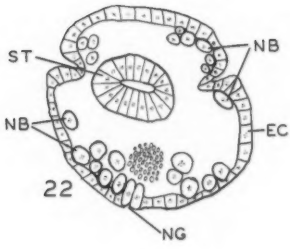
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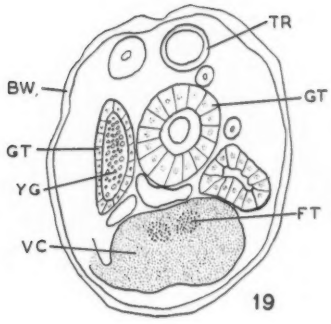
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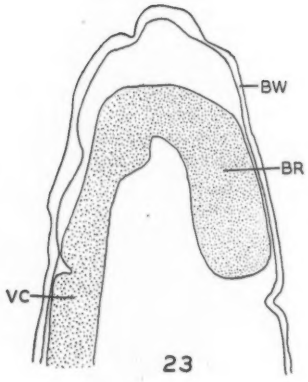
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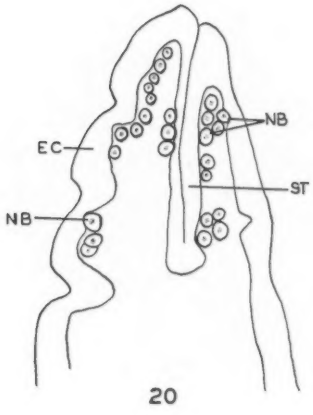
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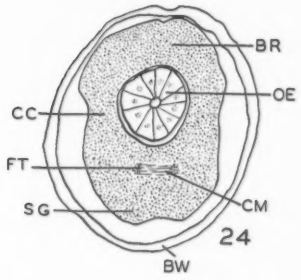
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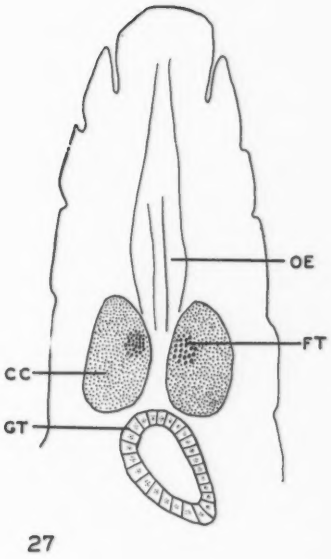
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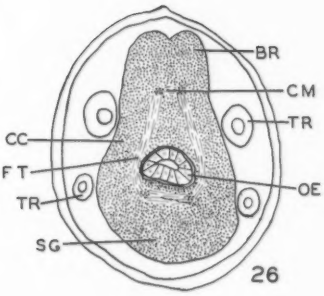
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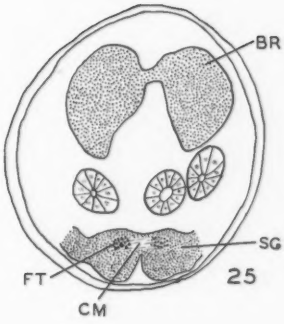
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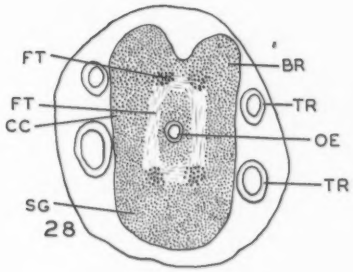
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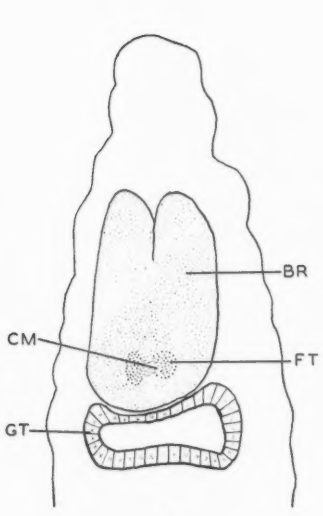

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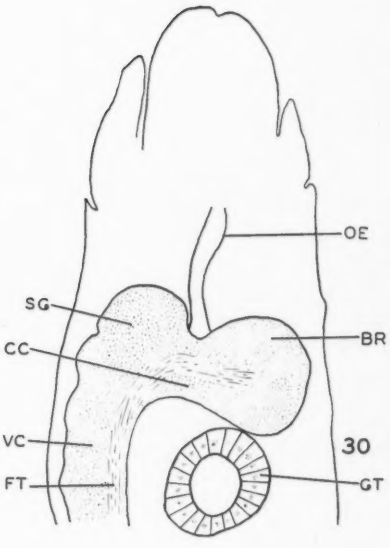

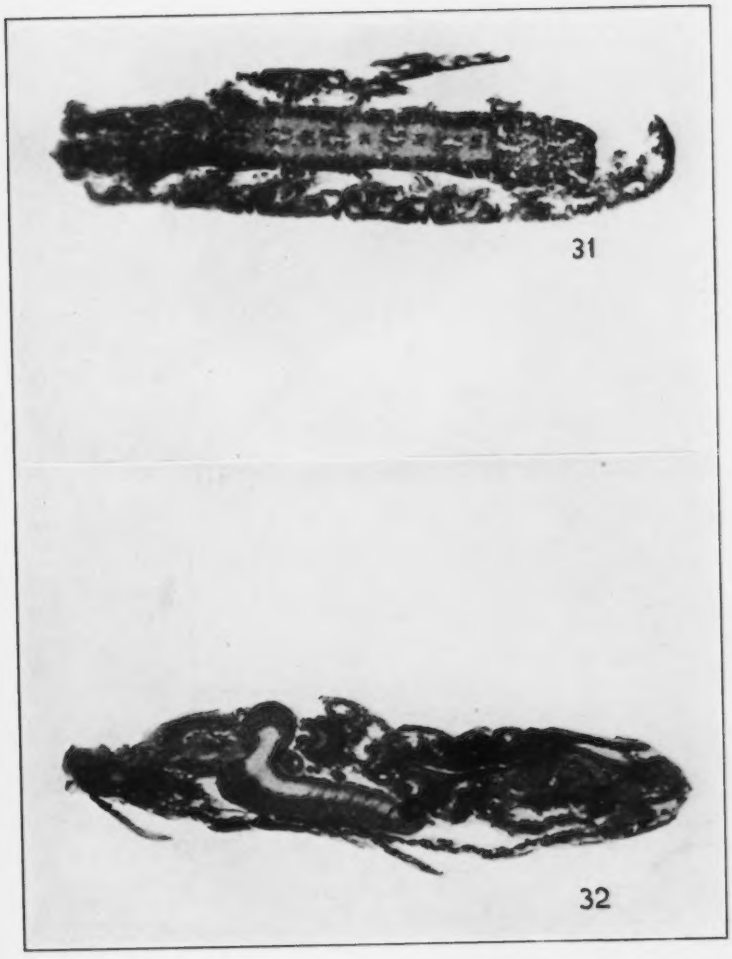
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NOTICE—ANNUAL MEETING

Preliminary Announcement

By action of the Executive Committee of the Entomological Society of America the Annual Meeting of the Society will be held at Richmond, Virginia, December 27–29, 1938. These meetings will be held at the same time and place as the American Association of Economic Entomologists and the American Association for the Advancement of Science. Detailed announcement of the meetings will be mailed to each member, October 15th.

PHOTOGRAPHS OF ENTOMOLOGISTS

Dear Prof. Kennedy:

Will you be kind enough to publish in the *Annals* in some shape or other the substance of what follows:

A great many of us have occasion to use in lectures, or in print, lantern slides or prints of photographs of other entomologists, and it is probably well known that there is a very large collection of the negatives of such photographs in the Bureau of Entomology and Plant Quarantine at Washington. But it is also known to very many of us that Mr. Julian P. Scott for a number of years made a hobby of taking photographs of scientific men (including entomologists) in many different parts of the world. He went all over this country, traveled extensively in Europe, Africa and the Orient, and accumulated a very great collection of films. Mr. Scott called on me a few days ago, after his return from a nine-month trip to Africa and told me that before leaving on that trip he deposited his entire collection of films with the Franklin Institute of Philadelphia, of which Mr. James Stokeley is the Secretary, and that he instructed Mr. Stokeley to have a print made, for anyone who should ask for it, of any photograph in the collection, charging a sum which would just cover the expense.

I think that the present location of this collection of films should be widely known among scientific men. I am sure that it contains very many of much interest, since I saw Mr. Scott at work at the International Congresses of Entomology at Ithaca and in Paris, and have also met him working in Shanghai, China.

Yours sincerely,

L. O. Howard.

ENTOMOLOGICAL SOCIETY OF AMERICA

PROCEEDINGS OF THE THIRTY-SECOND ANNUAL MEETING

Indianapolis, Indiana, December 28-30, 1937

The Entomological Society of America held its Thirty-second Annual Meeting on Tuesday, Wednesday and Thursday.

A joint symposium on the subject "The Relationship Between Insects and Plant Diseases" was held on Tuesday afternoon. The symposium was sponsored by the Entomological Society of America and the American Association of Economic Entomologists. Three members of the American Phytopathological Society took part in the symposium which was well attended by all three societies.

The Annual Public Address was given in conjunction with the Entomologists' Dinner. Professor P. J. Parrott was invited to give the Annual Address. His subject was "Loafing in Africa." He gave an account of an extended trip through Africa beginning at Cape Town in the south and ending at Cairo in the north. Professor Parrott reported on the various types of entomological work now being conducted at the various laboratories in Africa and illustrated his talk with several reels of moving pictures which he took during the course of his trip.

The program of papers presented at the three days meeting follows:

Opening Session, Tuesday Morning, December 28

The Society was called to order at 9:30 A. M. by PRESIDENT O. A. JOHANNSEN in the Lincoln Room of the Hotel Lincoln. The following papers were presented:

1. The Biology of *Pachycrepoideus dubius* Ashmead, a Pteromalid Parasite of *Piophila casei* Linné. (10 min.) (Lantern). HERBERT A. CRANDELL, Ohio State University, Columbus, Ohio.
2. New Therevidae (Diptera) from Utah. (5 min.) D. ELMO HARDY, Utah Agricultural College, Logan, Utah.
3. The Biology of the American Cockroach. (10 min.) GEORGE E. GOULD and H. O. DEAY, Purdue University, Lafayette, Indiana.
4. Oviposition by a Trypetid Fly, *Rhagoletis pomonella* Walsh (15 min.) (Lantern.) R. W. DEAN, Vassar College, Poughkeepsie, New York.
5. The *Hippelates* Flies or Eye-gnats: Some General Considerations. (10 min.) (Lantern). C. W. SABROSKY, Michigan State College, East Lansing, Mich.
6. Evolutionary Trends in Caddis Worm Case Construction. (10 min.) (Lantern.) MARGERY J. MILNE and LORUS J. MILNE. Randolph-Macon Woman's College, Lynchburg, Virginia.
7. Accessories for Teaching College Entomology. (10 min.) J. J. DAVIS, Purdue University, Lafayette, Indiana.
8. Biological Notes on *Blissus iowensis* Andre (Hemiptera—Lygaeidae). (10 min.) (Lantern.) G. C. DECKER and FLOYD ANDRE, Iowa State College, Ames, Iowa.
9. Hints on Bibliographies. (15 min.) (Lantern.) Z. P. METCALF, North Carolina State College, Raleigh, North Carolina.
10. Methods and Value of Recording by States an Annual Insect Population Survey. (10 min.) ROGER C. SMITH, Kansas State College, Manhattan, Kansas.

11. Concerning Some New and Interesting Aquatic Hemiptera. (10 min.) (Lantern.) H. B. HUNGERFORD, University of Kansas, Lawrence, Kansas.
12. Broods of *Anopheles quadrimaculatus* Say in the Tennessee Valley. (12 min.) (Lantern.) E. HAROLD HINMAN, Tennessee Valley Authority, Wilson Dam, Alabama.

The following committees were appointed by PRESIDENT JOHANNSEN:

Nominating Committee—C. T. BRUES, *Chairman;* R. E. SNODGRASS, C. L. METCALF.

Resolutions Committee—W. D. FUNKHOUSER, *Chairman;* ARTHUR GIBSON, WM. P. HAYES.

Auditing Committee—WM. A. RILEY, *Chairman;* B. ELWOOD MONTGOMERY, JOSEF N. KNULL.

The Society then adjourned to meet with the American Association of Economic Entomologists to hear the address of their president, Dr. F. C. Bishopp.

Second Session, Tuesday Afternoon, December 28

(Joint Session with American Association of Economic Entomologists.)

Symposium: "The Relationship Between Insects and Plant Diseases."

The session was called to order by DR. O. A. JOHANNSEN at 2:30 P. M. and the following papers were presented:

Insects in Relation to Diseases of Truck Crops. A. A. GRANOVSKY, University of Minnesota, St. Paul, Minn. Discussion Leader, D. M. DeLong, Ohio State University, Columbus, Ohio.

Insects in Relation to Diseases of Fruit Trees and Small Fruits. L. O. KUNKEL, Rockefeller Institute, Princeton, N. J. Discussion Leader, E. M. Searls, University of Wisconsin, Madison, Wis.

Insects in Relation to Diseases of Shade and Forest Trees. (Motion picture of Bark Beetles and Blue Stain of Norway Pine.) Introduction, J. G. LEACH, University of Minnesota, St. Paul, Minn.

Insects in Relation to Diseases of Cereal and Forage Crops. F. W. POOS, Bureau of Entomology and Plant Quarantine, Rosslyn, Va. Discussion Leader, J. W. Ingram, Bureau of Entomology and Plant Quarantine, Houma, La.

Problems Involved in Control of Plant Diseases and Insects. N. E. STEVENS, University of Illinois, Urbana, Ill.

PRESIDENT JOHANNSEN appointed the following fellows to act as alternates for absent members of the Executive Committee, which met at 7:00 P. M., Tuesday: E. P. FELT, WM. P. HAYES.

Third Session, Wednesday Morning, December 29

The Society was called to order at 9:30 A. M. by PRESIDENT JOHANNSEN and the following papers were presented:

13. Notes on Some Cimicid Parasites of Man and Animals. (14 min.) GEORGE M. LIST, Colorado Agricultural College, Fort Collins, Colo.
14. The Aortic Diverticula in the Odonata. (15 min.) (Lantern.) ARTHUR D. WHEDON, North Dakota State College, Fargo, N. D.
15. Collecting Fossil Insects in Amber in Northern Manitoba. (15 min.) (Motion pictures). C. T. BRUES, Harvard University, Cambridge, Mass.
16. A Synopsis of the Zoraptera, with Notes on the Biology of *Zorotypus hubbardi* Caudell. (15 min.) (Lantern.) ASHLEY B. GURNEY, Bureau of Entomology and Plant Quarantine, Washington, D. C.

17. Biological Notes on the Egg Parasites of *Malacosoma disstria* Hbn. (10 min.) (Lantern). A. C. HODSON, University of Minnesota, St. Paul, Minn.
18. Studies on Fat Metabolism in the Corn Earworm. (10 min.) (Lantern). L. P. DITMAN, University of Maryland, College Park, Md.
19. Studies on Carbohydrate Metabolism in the Corn Earworm. (5 min.) (Lantern). L. P. DITMAN, University of Maryland, College Park, Md.
20. Entomophagism in the Order Lepidoptera. (15 min.) (Lantern). W. V. BALDUF, University of Illinois, Urbana, Ill.
21. Some Features in the Head Structure of the Cicadellidae (Homoptera). (10 min.) (Lantern). C. S. SPOONER, East Illinois State Teachers' College, Charleston, Ill.
22. The Fruiting Stage of the Fungus Grown by the Leaf-cutting Ant, *Atta cephalotes*. (12 min.) (Lantern). NEAL A. WEBER, University of North Dakota, Grand Forks, N. D.

Fourth Session, Wednesday Afternoon, December 29

Following the call to order at 1:30 P. M. by VICE-PRESIDENT RUGGLES the following papers were presented:

23. An Analysis of Insect Growth Rates. (10 min.) LAURENCE C. WOODRUFF, University of Kansas, Lawrence, Kan.
24. An Analysis of Differential Growth Rates in Certain Orthoptera. (15 min.) (Lantern). NELLIE M. PAYNE, American Cyanamid Co., Stamford, Conn.
25. Apparent Nuclear-cytoplasmic Transfer of Material in Some Insect Blood Cells. (15 min.) (Lantern). J. FRANKLIN YEAGER, Bureau of Entomology and Plant Quarantine, Beltsville, Md.
26. Electrical Stimulation of Isolated Heart Preparations from *Periplaneta americana* Linné. (15 min.) (Lantern). J. FRANKLIN YEAGER, Bureau of Entomology and Plant Quarantine, Beltsville, Md.
27. An Analysis of the Blood of the Southern Armyworm. (By Title). FRANK H. BABERS, Bureau of Entomology and Plant Quarantine, Beltsville, Md.
28. Field Observations on the Insect Fauna of Thermal Springs in Java, Celebes and Sumatra. (15 min.) (Motion pictures). C. T. BRUES, Harvard University, Cambridge, Mass.
29. Geographical Distribution of Mutillidae, with Special Reference to the Islands of the Pacific Ocean and the New World. (15 min.) (Lantern). CLARENCE E. MICKEL, University of Minnesota, St. Paul, Minn.
30. A Study of Chalcidoid Wings. (10 min.) (Lantern). B. D. BURKS, Illinois Natural History Survey, Urbana, Ill.
31. The Rocky Mountain "Blackfly." (10 min.) (Lantern). HERBERT H. ROSS, Illinois Natural History Survey, Urbana, Ill.
32. The Entomological Interest of the Eastern Colorado Plains. (15 min.) MAURICE T. JAMES, Colorado Agricultural College, Fort Collins, Col.

Fifth Session, Wednesday Evening, December 29

Following the Entomologists' Dinner, PRESIDENT O. A. JOHANNSEN introduced PROFESSOR P. J. PARROTT, who gave the Annual Public Address on the subject "Loafing in Africa."

Sixth Session, Thursday Morning, December 30

The Society was called to order at 9:30 A. M. by PRESIDENT JOHANNSEN and the following papers were presented:

33. Distribution of the Genus *Phyllophaga* in the United States. (10 min.) (Lantern). PHILIP LUGINBILL and H. R. PAINTER, Bureau of Entomology and Plant Quarantine, Lafayette, Ind.
34. Occurrence and Responses of a Partial Second Generation of the European Corn Borer in the Lake States. (10 min.) A. M. VANCE, Bureau of Entomology and Plant Quarantine, Toledo, Ohio.

35. *Macrosiphum* Aphids Infesting *Artemisia*. (5 min.) G. F. KNOWLTON and M. W. ALLEN, Utah Agricultural College, Logan, Utah.
36. The Life Histories of *Agrion maculatum*. Beauv. and *A. aequabile* Say. (10 min.) ROSEMARY D. C. MARTIN, University of Toronto, Toronto, Canada. (Introduced by E. M. Walker.)
37. The Cervical and Thoracic Sclerites of *Grylloblatta*. (10 min.) E. M. WALKER, University of Toronto, Toronto, Canada.
38. Some Methods of Teaching Systematic Entomology to Beginners. (10 min.) H. E. JAQUES, Iowa Wesleyan College, Mt. Pleasant, Iowa.
39. Observations on the Egg and Larval Stages of *Trogoderma inclusum* Lec. (Dermestidae). (10 min.) O. W. ROSEWALL, Louisiana State University, Baton Rouge, La.
40. The Genus *Acinopterus* in the Western Hemisphere (Homoptera, Cicadellidae). (5 min.) (Lantern). R. H. BEAMER, University of Kansas, Lawrence, Kan.

The above meetings were attended by about 225, of whom 166 registered with the Secretary.

The following is a report of the Annual Business Meeting which was held Wednesday morning, December 30.

REPORT OF THE SECRETARY

During the year 1937 the following having been duly nominated and recommended were elected members of the Society by mail ballot of the Executive Committee:

ROBERT R. DREISBACH, 806 Mill St., Midland, Michigan.
GUENTHER WOLFGANG LASSMANN, Apartado No. 549, Mexico, D. F., Mexico.
BASIL G. MARKOS, Dept. of Zool. and Ent., Ohio State Univ., Columbus, Ohio.
CHARLES D. MICHENER, 418 N. Hudson Avenue, Pasadena, California.
JOHN Z. PELTON, 94 E. Tulane Road, Columbus, Ohio.
ALBERT R. SHADLE, 3435 Main St., Buffalo, N. Y.
E. V. WALTER, P. O. Box 495, Lafayette, Indiana.

PROFESSOR J. J. DAVIS kindly consented to act as the society's representative on the committee for arrangements for the Indianapolis meeting, and Mr. E. V. WALTER to act as the society's representative on the committee for exhibits at the same meeting.

With the approval of the Executive Committee PROFESSOR P. J. PARROTT was invited to give the annual public address of the Society at the Indianapolis meeting.

The President appointed DR. P. P. CALVERT to act as advisory representative on the Division of Biology and Agriculture of the National Research Council.

The Executive Committee met at 7:00 P. M., December 28, in the Hotel Lincoln, Indianapolis, Indiana, the following officers being present: O. A. JOHANNSEN, A. G. RUGGLES, A. C. KINSEY, CLARENCE E. MICKEL. Four other members of the committee were present: ALVAH PETERSON, WM. A. RILEY, W. D. FUNKHOUSER and C. J. DRAKE. The following alternates, designated by the President, served in place of absent members of the Committee: E. P. FELT, WM. P. HAYES.

The following were elected to membership in the Society:

WILLIAM H. ANDERSON, Rm. 429, U. S. National Museum, Washington, D. C.
PAUL ANDUZE, Direccion de Malariologia, Apartado Postal 1509, Caracas, Venezuela.
REV. JOSEPH ASSMUTH, Fordham University, New York, N. Y.

FRANK H. BABERS, Research Center, Beltsville, Maryland.
GEORGE W. BARBER, 56 Hillhouse Ave., New Haven, Connecticut.
WILLIAM HERBERT BENNETT, New York State College of Forestry, Syracuse, N. Y.
NORRIS D. BLACKBURN, Dept. of Zool. and Ent., Ohio State Univ., Columbus, Ohio.
GALE GATES BLEASDELL, 409 Eighth St. S. W., Le Mars, Iowa.
RICHARD MITCHELL BOHART, 1945 Yosemite Road, Berkeley, California.
WILLIAM G. BRADLEY, 1920 Parkwood Ave., Toledo, Ohio.
OSMOND P. BRELAND, North Dakota Agri. College, Fargo, North Dakota.
W. S. CORKRAN, Mosquito Control Commission, Lewes, Delaware.
CLYDE A. DENNIS, Tusculum College, Greeneville, Tenn.
HOWARD E. DORST, Utah Agri. College, Logan, Utah.
THOMAS N. FREEMAN, Entomological Branch, Dept. of Agri., Ottawa, Ontario, Canada.
THEODORE R. GARDNER, Bur. of Ent. and Pl. Quar., Box 150, Moorestown, N. J.
LYLE E. HAGMANN, R. 5, Hamilton Road, New Brunswick, New Jersey.
RICHARD HENRY HANDFORD, Box 250, Brandon, Manitoba, Canada.
D. ELMO HARDY, Dept. Ent., Utah Experiment Station, Logan, Utah.
GEORGE REDSTONE HOPPING, Box 308, Vernon, British Columbia, Canada.
JOHN K. JACOB, 2978 W. 38th Ave., Vancouver, British Columbia, Canada.
HUN KYU KIM, 153 Institute Place, Chicago, Illinois.
HERBERT CLAUS KNUTSON, Div. of Ent., University Farm, St. Paul, Minn.
IRA LA RIVERS, State College Station, Raleigh, North Carolina.
MANLIO MANZELLI, 258 Netherwood Ave., Plainfield, N. J.
ROSEMARY D. C. MARTIN, 24 Hawthorne Ave., Toronto, Ontario, Canada.
JOHN THOMAS MEDLER, Div. Ent., University Farm, St. Paul, Minn.
HERBERT E. MILLIRON, Dept. of Ent., Michigan State College, East Lansing, Michigan.
LORUS J. MILNE, Randolph-Macon Woman's College, Lynchburg, Va.
SAM C. MUNSON, 2300 G St., N. W., Washington, D. C.
WILLIAM PRESTON NYE, Dept. of Ent., Utah Experiment Station, Logan, Utah.
WILLIAM J. O'NEILL, 94 Church St., New Brunswick, N. J.
BOYD B. PALMER, Polytechnic Institute, San Germán, Puerto Rico.
J. R. PARKER, Bur. of Ent. and Pl. Quar., Bozeman, Montana.
LLOYD O. PETERSON, Indian Head, Saskatchewan, Canada.
W. LEVI PHILLIPS, 985 South Third East, Salt Lake City, Utah.
DWIGHT POWELL, 911 W. High St., Urbana, Ill.
CALVIN A. RICHINS, Dept. of Zool., University Park, Los Angeles, Calif.
WILLIAM WILSON SAMPSON, 112 Agri. Hall, University of California, Berkeley, California.
PHILIP MELVIN SCHROEDER, 1979 Ashland Ave., St. Paul, Minn.
GORDON E. SMITH, Health Section, T. V. A., Wilson Dam, Alabama.
MARION E. SMITH, Dept. of Ent., Univ. of Illinois, Urbana, Ill.
JOHN CLYDE SWARTZWELDER, Louisiana State Univ. Medical Center, New Orleans, Louisiana.
MARY TALBOT, Lindenwood College, St. Charles, Missouri.
HENRY DEVLIN THOMAS, Dept. of Ent., Univ. of Kansas, Lawrence, Kansas.
GETULIO B. VIADO, Agricultural College, Laguna, Philippine Islands.
WILLIAM ELMER WATKINS, Dept. of Ent., Utah Agri. College, Logan, Utah.
MERLE W. WING, 35 Bradbury St., Old Town, Maine.
ELTON N. WOODBURY, Dept. Zool. and Ent., Ohio State Univ., Columbus, Ohio.

The total number of new members for 1937 is 56.

The following have resigned during the year:

A. B. BAIRD, HASTINGS N. BARTLEY, L. CAESAR, S. E. CRUMB, G. GORDAN DUSTAN, JOE K. ELLSWORTH, DAVID E. FINK, LYDIA J. GAMBRELL, R. W. HAEGELE, J. P. HARRIS, R. M. JONES, PHILIP LEVEREAULT, W. L. MCATEE, GEO. E. MARVIN, R. W. MORELAND, W. F. MOROFSKY, ARTHUR E. MUELLER, JOHN OSCAR PEPPER, O. E. PLATH, J. B. POLIVKA, L. B. REED, JANUS E. RIDLEY, M. T. SMULYAN, B. R. SPEICHER, C. B. WILLIAMS, ROSWELL C. WILLIAMS, JR., WARREN WILLIAMSON.

The following have been automatically dropped from membership either because of failure for three or more years to pay dues or because they cannot be reached:

DWIGHT F. BARNES, F. F. BIBBY, FREDERIC C. CARNOCHAN, FRED O. DODD, TEISO ESAKI, JOHN T. GAMBLE, D. W. GRIMES, F. E. GUYTON, D. L. MOODY, ANDREW R. PARK, JR., J. N. RONEY, FIDEL DEL ROSARIO, JOHN A. ROWE, U. S. SHARGA, FRANK E. SHEAFFER, OWEN J. SMITH, LYLE STEPHENSON, JAMES M. SWAINE, H. S. SWINGLE.

The Executive Committee unanimously nominated T. D. A. COCKERELL, H. T. FERNALD, and C. P. GILLETTE for Honorary Fellows and they were elected by the Society.

The Executive Committee elected the following Fellows:

H. F. BARNES, C. BETTEN, M. W. BLACKMAN, W. H. BRITTAIN, S. W. BROMLEY, S. C. BRUNER, C. P. CLAUSEN, R. T. COTTON, A. E. EMERSON, S. E. FLANDERS, H. M. HARRIS, E. H. HINMAN, W. M. MANN, H. B. MILLS, T. B. MITCHELL, ANN H. MORGAN, M. A. PALMER, A. PETRUNKEVITCH, P. A. READIO, H. H. ROSS, H. F. SCHWARZ, HERBERT SPENCER, J. S. WADE, W. R. WALTON, H. B. WEISS, J. F. YEAGER.

The Society has suffered loss by death of the following eleven members during the past year:

H. L. BOWERS, LAWRENCE BRUNER, P. W. CLAASSEN, C. R. CROSBY, PHILIP DOWELL, SIGMUND GRAENICHER, V. L. KELLOGG, L. C. MARSTON, JR., MRS. ELLEN ROBERTSON-MILLER, FRANK J. PSOTA, W. M. WHEELER.

H. L. BOWERS, a member of our Society since 1918, passed away early in the year 1935 according to a communication received from his widow. Mr. Bowers was graduated from Lehigh University and at the time of his death was chief metallurgist for the J. L. Mott Co., Trenton, New Jersey.

LAWRENCE BRUNER, a Charter Member of our society and a FELLOW since 1907 was born at Catasauqua, Lehigh County, Pennsylvania, March 2, 1856, and died in Berkeley, California, January 30, 1937. In 1870 his family joined an early pioneer group that founded West Point, Nebraska. In 1880 he assisted the U. S. Entomological Commission in connection with grasshopper investigations under the direction of the late C. V. Riley. In 1888 he was appointed entomologist of the Nebraska Experiment Station. In 1890 he became instructor at the University of Nebraska and in 1895 was appointed Professor in Entomology which position he held except for several leaves of absence, until 1931. He was president of our Society in 1917 and was also president of the American Association of Economic Entomologists in 1900. In 1915 the Governor's Council named him the most distinguished Nebraskan and appointed him as representative of the State of Nebraska at the Panama Exposition. After 1915 he spent a great deal of time in California and was appointed professor emeritus in entomology at the University of Nebraska in 1931. In 1881 Professor Bruner married Marcia Dewell, of which marriage two daughters now survive.

PETER WALTER CLAASSEN, a member of our Society since 1918 and a FELLOW since 1929, was born on March 17, 1886, on a farm near Hillsboro, Kansas, and died on August 16, 1937. He attended McPher-

son College and later the University of Kansas where he received his Bachelor's Degree in 1913. He received his Ph. D. degree from Cornell University in 1918. From 1918 until his death he was in charge of the course in elementary biology at Cornell University. During the academic year 1924–25 he was on leave from Cornell and spent the year at Peiping, China, reorganizing the work in biology at Tsing Hua College. In 1917 he married Miss Evelyn Strong who survives him with a young daughter and son.

CYRUS RICHARD CROSBY, a CHARTER MEMBER of our Society and a FELLOW since 1929, was born January 9, 1879, at Penn Yan, New York, and died on January 11, 1937. After graduating from Cornell University in 1905 he was engaged until 1906 as assistant entomologist at the University of Missouri. Returning to Cornell in 1906 he held the position of entomologist of the Experiment Station and assistant professor of entomological investigations, and finally from 1913 that of extension entomologist. His wife and a son survive him.

PHILIP DOWELL, a member of our Society since 1914 was born at Attica, Indiana, December 3, 1864, and died late in the year 1936. For many years he was a teacher of biology in the high schools of New York but retired in the year 1928 and in recent years has made his home in Glenwood, Florida. He took his Master's degree at Yale in 1896 and his Ph. D. degree at Augustana College in 1900. His chief interest was in botany but he was a member of the New York Entomological Society as well as our own and took an active part in the affairs of the Staten Island Institute of Arts and Sciences.

SIGMUND GRAENICHER, a CHARTER MEMBER of our Society and a FELLOW since 1935, was born at Natchez, Mississippi, on April 29, 1855, and died on September 16, 1937. Mr. Graenicher was sent to Switzerland to be educated and for a time studied to be an engineer but later devoted himself to biological subjects. He studied marine life at Nice, and received his Ph. D. degree at Basel in 1884. He then entered the field of medicine and took his degree in that field at Munich in 1886. He then returned to Milwaukee and in addition to his medical practice he worked for years as honorary curator of the Museum of Natural History at Milwaukee. In 1900 he gave up the practice of medicine and became curator of invertebrate zoology at the Museum. In 1916 he retired from the Museum and moved to Florida, largely on account of his health. He is survived by a daughter, Mrs. Sylva G. Martin.

VERNON LYMAN KELLOGG, a CHARTER MEMBER of our Society and a FELLOW since 1907 was born on December 1, 1867, at Emporia, Kansas, and died on August 8, 1937, at Hartford, Connecticut. Graduating from the University of Kansas in 1889 he spent the next four years preparing himself as a zoologist at the University of Kansas, Cornell University, Leipzig and Paris. As a zoologist he was active in his early years in entomological fields and was president of our Society in 1915. The World War took him away from zoology and completely changed the course of his life so that he never returned to academic work. After the war he became permanent secretary of the National Research Council. He received honors from many countries for his

relief work in Belgium and was active in the affairs of many of our national biological societies. During the period from 1894–1920 he was professor of entomology and lecturer of bionomics at Stanford University where he worked in close association with David Star Jordan. During this period he made many contributions to the field of entomology, including several books. Dr. Kellogg not only played an active part in the development of the science of entomology in the United States but also played an even greater part in the development and outlook of science as a whole during the last quarter century.

LEON CHESTER MARSTON, JR., a member of our Society since 1930, died on June 22, 1937. He was thirty-two years old. He had been an instructor in Entomology at the University of Tennessee and at the time of his death had recently been appointed assistant professor of entomology at Pennsylvania State College.

MRS. ELLEN ROBERTSON-MILLER, a CHARTER MEMBER of our Society, died on March 14, 1937. For a number of years she was a nature study teacher in the Cleveland Public Schools and at the time of her death was living at Coronado Beach, Florida.

FRANK J. PSOTA, a member of our Society since 1916, died on April 13, 1936. Dr. Psota was a practising physician in Chicago but was much interested in the Coleoptera and had built up a very large collection of insects belonging to that order.

WILLIAM MORTON WHEELER, a CHARTER MEMBER of our Society and an HONORARY FELLOW since 1932, was born on March 19, 1865, at Milwaukee, Wisconsin. In 1892 he took his doctorate in philosophy at Clark University and in the same year was appointed instructor at the University of Chicago, but immediately took a year's leave of absence for study in Europe. In 1896 he was appointed assistant professor at Chicago and in 1899 was appointed head of the Department of Zoology at the University of Texas. In 1903 he became curator of invertebrate zoology at the American Museum of Natural History and in 1908 he was appointed professor of economic entomology at Harvard University with which institution he was connected at the time of his death. Dr. Wheeler was the second president of our Society in 1908 and was a Fellow or member of many scientific societies. His wife and two children survive him.

Following the reading of these brief memorials the members stood in silence in memory of the eleven who have died during the past year.

The total membership on December 31, 1937, is 940.

The following were elected by the Executive Committee to the Editorial Board of the ANNALS for the term expiring December 31, 1940: J. MCDUNNOUGH, F. C. BISHOPP, H. H. KNIGHT.

The Executive Committee voted to contribute $10.00 towards the expenses of the Biologists' Smoker at Indianapolis, Indiana.

The Executive Committee voted that we indicate to the Union of American Biological Societies our continued interest in Biological Abstracts and our willingness to co-operate in arriving at some feasible plan for its maintenance, but that we do not consider feasible the pro-

posed plan of assessing each member of our society $3.00 annually for its support.

PROFESSOR A. C. KINSEY was appointed by PRESIDENT O. A. JOHANNSEN to represent the Society at the Indianapolis meetings of the Union of American Biological Societies.

The Executive Committee voted to recommend to the Society that the annual dues be increased to $4.00.

The Executive Committee voted to assist in the sponsorship of entomological meetings at the Summer meeting in 1938 of the American Association for the Advancement of Science at Ottawa, Canada.

The Executive Committee voted to publish the membership list.

The Executive Committee postponed the selection of a meeting place for 1938.

The Executive Committee adjourned at 11:00 P. M.

Respectfully submitted,
CLARENCE E. MICKEL, *Secretary.*

On motion the Secretary's Report was accepted and the recommendations of the Executive Committee adopted.

REPORT OF THE TREASURER

CURRENT FUNDS

RECEIPTS

Balance on hand in bank, December 16, 1936 (see Annals, Vol. 30, p. 184)	$1,893.60
From Annual Dues of Members to December 16, 1937	2,800.74
Payment on loan by Thomas Say Foundation, J. J. Davis, Sec	100.00
Received from Clarence H. Kennedy, Managing Editor of Annals	150.00
Sale of six membership lists	1.50
Total	$4,945.84

EXPENDITURES

Postage, including 3,000 three-cent stamped envelopes	$ 124.80
Spahr & Glenn Printing Co., Printing December, 1936, and March, June and September, 1937, Annals	3,456.97
Letterheads for President and Secretary-Treasurer, and stamped envelopes for President	17.00
Printing preliminary announcements, blank forms and programs	100.75
Office Supplies	6.50
Clerical Services	26.50
Biologists' Smoker, Atlantic City meeting	10.00
Expense of exhibits and guests at Atlantic City meeting	26.15
Checks returned by bank, and returned to members	35.00
Exchange on checks	23.87
Payment of Loan by Thomas Say Foundation, transferred to Permanent Fund	100.00
Telegrams	3.97
Total	$3,931.51
Balance in checking account, December 16, 1937	1,014.33
Total	$4,945.84

LIABILITIES

The Society owes the publishers for the December, 1937, Annals. Of the above cash receipts for dues $1,228.25 is for 1938 dues.

PERMANENT FUND

RECEIPTS

Balance in Savings Account, December 16, 1936	$3,206.52
Interest on Savings Account December 16, 1936, to December 16, 1937	48.36
Interest on Liberty Bond 45554-D	1.44
Payment by J. J. Davis on Thomas Say Foundation Loan	100.00
Total	$3,356.32

EXPENDITURES

(None)

Balance in Savings Account, December 16, 1937	$3,356.32

RESOURCES

Liberty Bond 45554-D	$ 50.00
Savings Account	3,356.32
Balance in checking account	1,014.33
Total	$4,420.65

Respectfully submitted,

CLARENCE E. MICKEL, *Treasurer.*

On motion the Treasurer's Report was accepted, subject to the approval of the Auditing Committee.

REPORT OF THE MANAGING EDITOR OF THE ANNALS

I wish to report that 654 pages of material have been published in Volume XXX for 1937 as against 800 pages for 1936 and 519 pages for 1935. This size of Annals volume leaves the Society with very little financial margin because of which we have concurred with the Editorial Board in its recommendation to the Executive Committee that the price of the Annals to members be raised to $4.00 per year.

The quality of the manuscript received by the Annals has remained high. We receive few manuscripts that have to be returned for lack of quality.

We wish to thank the Assistant Editor, Mr. Birely J. Landis, Professor Ralph Davidson and Dr. D. J. Borror, for help in reading manuscript and proof.

The financial summary follows:

RECEIPTS

Non-member subscriptions	$ 666.37
Sale of Back Numbers	235.15
From Authors for Cuts	638.44
Bank Balance from 1936	6.01
Bank Balance December 23, 1937	20.04
Total	$1,566.01

EXPENDITURES

To Engravers	$ 652.93
Office Help	356.00
Postage	157.97
Miscellaneous	79.07
To Secretary-Treasurer	300.00
Bank Balance, December 23, 1937	20.04
Total	$1,566.01

Respectfully submitted,

CLARENCE H. KENNEDY, *Managing Editor.*

On motion, the report was accepted subject to the approval of the Auditing Committee.

REPORT OF THE TREASURER OF THE THOMAS SAY FOUNDATION

RECEIPTS

Balance on hand, December 17, 1936	$ 95.73
Received from 1936 sales not previously reported	13.50
1937 Sales of Volume I (7 copies)	17.25
1937 Sales of Volume II (16 copies)	69.25
1937 Sales of Volume III (12 copies)	42.20
Interest on Savings Account, Jan. 1, 1936, to June 30, 1937	2.75
Total	$240.68

EXPENDITURES

Final payment on loan from Entomological Society of America	$100.00
Express and postage on books	4.46
Miscellaneous postage	1.20
Total	$105.66
Balance in Purdue State Bank, December 21, 1937	135.02
Total	$240.68

The Foundation has assets in the form of books (Volumes I, II, and III) which will bring in a potential income of $100.00 to $200.00 each year, and has absolutely no outstanding indebtedness, having made full payment of the loan of $500.00 from the Entomological Society of America to aid in publishing Volume III.

As editor of the Thomas Say Foundation and for the Thomas Say Foundation Committee, it seems advisable at this time to give consideration to the publication of a fourth volume if a manuscript of high quality and one which will have a reasonable demand is available. It is obvious from our past years experience that as new volumes are added we may anticipate increasing sales of old volumes, and that in the future, with possible outside donations to the Foundation, we may anticipate a steady income which will permit more regular publication of new volumes.

Respectfully submitted,

J. J. DAVIS, *Treasurer and Editor.*

On motion the report was accepted subject to the approval of the Auditing Committee.

REPORT OF THE AUDITING COMMITTEE

We, the undersigned members of the Auditing Committee, beg to report that we have carefully examined the accounts of the Treasurer of the Society, the Managing Editor of the ANNALS and the Treasurer of the Thomas Say Foundation for the year 1937, and have found them to be correct and properly balanced.

Respectfully submitted,

WILLIAM A. RILEY, *Chairman,*
B. ELWOOD MONTGOMERY,
JOSEF N. KNULL.

REPORT OF THE NOMINATING COMMITTEE

Your Committee places in nomination the following Fellows of the Entomological Society of America, to fill the designated vacancies for the year 1938:

President—A. L. MELANDER.

First Vice-President—W. D. FUNKHOUSER.

Second Vice-President—C. F. W. MUESEBECK.
Secretary-Treasurer—CLARENCE E. MICKEL.
One Member of the Executive Committee to Serve Until 1940—R. C. OSBURN.
Councilors to the American Association for the Advancement of Science—J. J. DAVIS and O. A. JOHANNSEN.
One Member of Joint Committee on Insect Collections of America, to Serve Until 1940—R. H. BEAMER.
One Member of Joint Committee on Advancement of Official Entomology—GEORGE A. DEAN.
Two Members of Thomas Say Foundation Committee—A. C. KINSEY and E. O. ESSIG.

Respectfully submitted,
C. T. BRUES, *Chairman*,
C. L. METCALF,
R. E. SNODGRASS.

On motion the report was accepted and the Secretary instructed to cast a ballot for the election of the persons nominated. This being done, they were duly elected.

REPORT OF THE JOINT COMMITTEE ON INSECT COLLECTIONS, OF THE ENTOMOLOGICAL SOCIETY OF AMERICA AND THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The following statements indicating changes in various institutional insect collections have been received.

Academy of Natural Sciences, of Philadelphia, Pa.—During the year 1937 building changes permitted an entire rearrangement of the quarters occupied by the Department of Entomology, greatly increasing the area available for the study collections and augmenting the facilities for students. The replacement of a discontinued type of metal case by additional units of the new design double steel cabinets, holding forty-eight of the Academy's standard glass-top boxes, has been continued. The completion of this program, however, is, of necessity, to be spread over a number of years.

The major additions to the collections during the year 1937 have been: 12,000 insects of all orders from the southwestern United States taken by the Southwest Orthoptera Survey, 1928; 5,000 Orthoptera from Mexico and Texas, presented by H. Radclyffe Roberts; 2,000 Orthoptera from Madagascar, purchased; 3,250 insects of all orders from northeastern Brazil, presented by Dr. R. von Ihering; 1,500 determined exotic Scarabaeidae, presented by Mark Robinson; 1,500 determined Noctuidae from the United States, presented by Dr. Frank M. Jones; 1,000 insects of various orders from Panama, collected by the Panama Expedition, 1937; 40 determined Sphingidae, presented by Dr. B. Preston Clark. The expeditions named were official Academy activities. JAMES A. G. REHN.

American Museum of Natural History, New York, N. Y.—As in former years The American Museum of Natural History is greatly indebted to friends who gave us types and other named specimens. In addition to these the Museum, by reason of financial contributions from friends, was able to purchase the Gunder collection of butterflies including about 232 types. FRANK E. LUTZ.

Brigham Young University, Provo, Utah.—During the year 1937, there were added to the collections 4,000 specimens from Garfield, Kane, and Cache Counties; also 1,500 specimens which were collected during July in Yellowstone and Glacier National Parks and Waterton National Park in Canada. There have also been added the type specimens of five species and paratype specimens of twenty-three species of Diptera and Coleoptera. This brings the Brigham Young University Entomological Collection to over 200,000 pinned specimens.

VASCO M. TANNER.

California Academy of Sciences, San Francisco, Calif.—The insect collection now numbers over 1,000,000 specimens, approximately 95,000 having been added in 1937, including the Adalbert Fenyes collection of Coleoptera, estimated at 75,000 specimens. The Fenyes collection contains 2,700 determined species of Staphilinidae, of which 1,800 are Aleocharinae. Accompanying this material is a manuscript by Dr. Fenyes treating the world Aleocharinae and containing 766 excellent colored drawings.

Eighty-four holotypes and allotypes were added during the year.

Twelve new cases and 200 standard drawers, 17 by 19 inches, were acquired, making possible considerable expansion of the regular tray collection.

E. P. VAN DUZEE.

Canadian National Collection, Ottawa, Ont.—About 20,000 new specimens were acquired from faunistic surveys conducted during the past season at Churchill, Man., Great Bear Lake, N. W. T., southern British Columbia, southern Ontario, and in the Ottawa district. Type material of 136 North American species was added to the collection during the past year; the collection now contains type material of 4,318 North American species. W. J. BROWN.

Clemson Agricultural College and Experiment Station, Clemson, S. C.—Our state list now stands at 5,472 species of insects, 117 species having been added during the year. Most of these 5,472 species are represented in our collections by named specimens. In addition, there are several hundred authoritatively determined species from surrounding states.

Since last spring our collection has been housed in a special museum room in Long Hall, our new agriculture building. This is a room 20x21 feet in which is housed also our mammal and bird skin collections.

Our new equipment includes 75 new glass-topped museum cases (Cornell Type Drawers) and five new counter-height, pest-proof metal storage cabinets each to hold 22 of the Cornell Drawers. The plan is to add pinning trays as soon as possible and transfer our named collection to this equipment. DAVID DUNAVAN.

Colorado State College of Agriculture and Mechanic Arts, Fort Collins, Colo.—Approximately 10,000 specimens, largely Colorado material, were collected and added to the regular collections during the year. The donation of the E. P. Taylor collection of Coleoptera, numbering about 1,000 specimens, is also recorded. The named collection has been increased by about 100 species, and paratypes of 10 species have been added. MAURICE T. JAMES.

University of Colorado Museum, Boulder, Colorado.—The addition of about 800 specimens from the Science Lodge region, at about 9,000–14,000 feet altitude along the Continental Divide in Colorado, and 800 specimens by a recent gift, brings the Museum collections to a total of about 22,950 specimens. Of these 7,450 are identified (3,275 species) and 15,500 are unidentified. The unidentified specimens are available to specialists for study. About 45 species are represented by type material.

There are several thousand fossil insects, including hundreds of types, mostly from the Florissant and Creede deposits.

The University Museum moved into its new building during September and October, and opened to the public on November 16th. The two lower floors are devoted to exhibits, including a good representation of insects. The study collections of insects are temporarily housed on the top floor and are being transferred to glass-topped drawers in steel cabinets. Special care is given to type specimens. The building is entirely fireproof and offers thorough safety and convenient access to the collections. HUGO G. RODECK.

Iowa State College, Ames, Iowa.—As a result of Mr. Gale Bleasdell's intensive studies of Iowa Rhynchophora approximately 300 species of this group were added to the collection. Other additions were odd species here and there.

H. H. KNIGHT.

Kansas State College of Agriculture and Applied Science, Manhattan, Kansas.—During the year at least 6,000 specimens were pinned and labeled and added to the collections of the Department of Entomology; also identified material of at least 100 species not previously represented in the named series.

The chief addition to the collection has been the Warren Knaus collection of

Coleoptera and his scientific library. Doctor Knaus was graduated from Kansas State College in 1882, and was given the honorary degree of Doctor of Science in 1927. He early became interested in the Coleoptera and collected widely in Kansas, Oklahoma, Colorado, Nebraska, Arizona, Texas, Nevada, New Mexico, California, Utah and Mexico. During his lifetime he built up a collection, mostly Coleoptera, of 90,000 specimens consisting of approximately 10,000 species. In March, 1917, he gave the collection to the Kansas State College but it remained in his office until after his death on June 29, 1937. On July 8, this valuable collection and his large entomological library were transferred to the college. The insect collection is stored in a fireproof vault and the library, consisting of complete series or long runs of the more important entomological journals of the United States, have been placed in the college library. Some of the sets of periodicals and the large collection of taxonomic reprints which are duplicates will be added to the departmental library. While many of the specimens are named, there is a considerable portion of the collection in need of arranging and determination. The collection makes important additions to the college collection from the fauna of the Southwest. About 50 species are represented by type material.

A two-door steel cabinet holding two tiers of 25 tray drawers each was purchased during the year, as well as 50 new tray drawers. It is expected that additions in the form of identifications, exchanges and transferred specimens will largely fill the cabinet next year. ROGER C. SMITH.

Francis Huntington Snow Entomological Museum, Lawrence, Kansas.—During the past year 83,177 specimens have been added to the museum. The number of species determined this year is 1,010. Species new to the collection total 436, and types of new species added, 157. The Coleoptera collection has been further strengthened by the addition of the Barrett Collection of Scarabaeidae, comprising 79 Schmitt boxes and including 57 type species.

Doctor R. H. Beamer and party collected in Colorado, North and South Dakota, Minnesota, Michigan, Wisconsin, and Canada. H. B. HUNGERFORD.

Illinois State Natural History Survey, Urbana, Illinois.—The chief additions to the Survey collection this year have been in the aquatic orders, as follows: Trichoptera 85,000 specimens, Plecoptera 2,500, Plectoptera 1,000. The stonefly collection is completely identified and arranged and numbers approximately 140,000 specimens.

In the terrestrial groups additions were as follows: Cicadellidae 6,000, Miridae 2,000, miscellaneous groups 10,000, with especial reference to phytophagous species. The completion of the study of *Sialis* leaves our collection with about 3,500 specimens of this genus.

Type additions are as follows: Cicadellidae 10 species, Sialidae 12, Plecoptera 14, Trichoptera 9, other groups 14. HERBERT H. ROSS.

Los Angeles Museum of History, Science and Art, Los Angeles, California.—Approximately 25,000 specimens were added to the insect collections during the year, of which total about 8,400 are Lepidoptera. About 1,000 Schmitt boxes were acquired to care for the expanding collections and shelf room was also correspondingly increased.

W. D. Pierce has been appointed Assistant Entomologist and he has begun the arrangement of the collections of Coleoptera. JOHN A. COMSTOCK.

Massachusetts State College, Amherst, Mass.—The entire college collections of Diptera and Hemiptera were expanded into 56 Cornell-type drawers for the main collection and many more for the duplicate collection, following the sequence of families in the "List of the Insects of New York." About 5,000 Gaspe Peninsula insects, mostly unworked, were added by Dr. C. P. Alexander, together with about 700 named species of higher Diptera from his private collection. Several hundred Coleoptera were added after their determination by Mr. C. A. Frost. Mr. W. T. Davis named and gave to the college about 25 species of Cicadidae. About 100 species of parasitic Hymenoptera have been added by members of the staff, together with many insects in other orders. Two graduates of the college, Mr. J. F. Martin and Mr. R. Parker, have given to the college their collections left here for many years on deposit; while Mr. J. C. Crawford and Dr. J. D. Hood have made many important contributions to the slide collection of Thysanoptera.

HARRY D. PRATT.

Milwaukee Public Museum, Milwaukee, Wis.—The insect reference collections total approximately 200,000 specimens, which are well housed and cared for. All except the Lepidoptera are arranged in labeled trays in standard museum drawers, and the entire collection is card indexed. The Lepidoptera are held in a long series of Riker mounts. Type material occurs especially in the Hymenoptera.

The display collections of insects are exceptionally extensive and well developed, special emphasis being placed on the Wisconsin fauna. During the past year a considerable number of new natural group exhibits have been prepared.

C. F. W. MUESEBECK.

University of Minnesota, St. Paul, Minn.—Approximately 54,000 specimens have been added to the collection during the year. Mr. C. N. Ainslie of Sioux City, Iowa, has presented the collection with 13,000 additional determined and undetermined insects, many of which were collected in the state of Minnesota and belong principally to the orders Lepidoptera, Coleoptera and Diptera. Among the most important purchases for the year were 3,000 specimens of Mutillidae and related Hymenoptera from Arizona, 700 miscellaneous insects from British Guiana and approximately 10,000 determined and undetermined specimens, mostly Hemiptera, from Texas and Utah. The department staff and students have added considerable material to various groups during the year, the most important among which are 6,000 specimens of the genus Phyllophaga, 2,000 specimens of Scolytidae, 4,000 specimens of Trichoptera, 500 specimens of Syrphidae, 500 specimens of Sphecidae and 400 vials of Ephemerida. Approximately 500 specimens of determined Mutillidae were added, many of which were types. Two hundred insect drawers have been added to the equipment during the year.

One of the most important projects being carried on at the present time is the cataloging of the material in the collection, the work being done by Federal Aid students of the University. When this is completed there will be a card catalog giving complete information about every specimen in the collection.

Material from the University collection is available to responsible students making a study of any particular group. CLARENCE E. MICKEL.

Montana State College and Agricultural Experiment Station, Bozeman, Mont.—Approximately 200 species have been determined and are to be incorporated with the collections. The collections are in the process of being transferred to the unit tray system. All alcoholic material is being worked over and put in a more available form. HARLOW B. MILLS.

Museum of Comparative Zoology, Cambridge, Mass.—The Eddy Collection, received last year, proved to have fully a third more specimens than estimated; in the Spring Dr. Darlington brought down the remainder, over 4,000 specimens, Dr. J. Bequaert gave over 2,800 native Hymenoptera and Diptera, mostly named, and over 300 neotropical Hymenoptera. Mr. Fairchild has added over 1,000 Brazilian insects, Mr. Parsons several hundred European insects collected the past summer, Miss Lawrence sent nearly 1,000 Oriental insects, and several hundred came from the Asiatic Primate Expedition.

By purchase there were acquired about 800 Neuroptera and Hymenoptera, and over 2,000 Arachnida from South China, about 2,000 Neuroptera, Diptera, Hymenoptera and Carabidae from South India, and from Mr. Roys several hundred West Indian insects. The Curator collected about a thousand local forms. The numerous smaller gifts and purchases add over 6,000 specimens from Massachusetts to New Zealand.

With the death of Dr. Wheeler thousands of pinned and alcoholic ants that he kept in his office came to the Museum, and his assistant, Miss Bartlett, was retained to attend to assorting the material, returning borrowed specimens, and adding identified material to the collection.

Since July Mr. R. Bartsch had been helping in the Lepidoptera Room; the desirable Eddy material has been incorporated, and a new arrangement of the Nearctic Geometridae completed, adding the Cassino Collection.

Determination of material loaned by the Museum, work on the collection, exchanges, and duplicates from material loaned to the Museum have given names to thousands of species, far more than in any previous year.

Types of 771 species were catalogued during the year.

NATHAN BANKS.

Ohio State University, Columbus, Ohio.—About 35,000 insects were added to our collections during the past year, chief of which might be mentioned: Determined material from Dr. G. F. Knowlton of the Utah Experiment Station; southwestern and Mexican Coleoptera contributed by Dr. E. D. Ball; over 1,000 slides of Aphiidae and Coccidae by Prof. Herbert Osborn; New England insects by Dr. R. C. Osburn; a collection of Nebraska and Iowa Cicadellidae from Dorothy J. Knull, and about 30,000 southwestern insects collected by the curator and wife.

J. N. KNULL.

Oregon State Agricultural College, Corvallis, Ore.—Approximately 2,000 new specimens were acquired during the year. Two hundred slides of Thysanoptera were donated by A. B. Black. Paratypes in various groups have been added to the collections, especially in the Plecoptera and Ichneumonidae.

Eight new museum cases, two of which are for specimens preserved in liquid, have been obtained. DON C. MOTE.

Purdue University, Lafayette, Indiana.—While we have been making rather extensive additions to our collections, particularly in the Hemiptera and Homoptera, our principal addition was the acquisition of the collection and library of W. S. Blatchley. The collection includes 211 Schmitt boxes of very closely pinned specimens, totaling approximately 75,000 and embracing chiefly the orders Coleoptera, Orthoptera and Hemiptera. There are 13 Schmitt boxes of Lepidoptera and miscellaneous orders. The collection also includes approximately 500 type specimens. I might add that Blatchley made quite a few collections of Hemiptera and Coleoptera in particular in South America. J. J. DAVIS.

Texas Agricultural Experiment Station, College Station, Texas.—The insect collection contains approximately 70,000 specimens (principally Texas species), of which about 40,000 are determined. The identified material includes about 5,000 species distributed mainly among the following orders: Coleoptera, Diptera, Hemiptera, Lepidoptera, Hymenoptera, and Orthoptera. The normal number of accessions were made during the year; there were no extensive additions to the collection, either through donations or purchase of material.

About 25,000 cards of the Station's Catalogue of the insects in the State have been typed. The records accumulated on Asilidae have been published and a manuscript on the Orthoptera of Texas is one-third completed.

H. J. REINHARD.

United States National Museum, Washington, D. C.—Although much needed, there has been no increase in space allotment and only the usual increment of cases and drawers for the housing of the collection.

The more outstanding accessions for the year: by purchase, a collection of approximately 1,500 specimens of Canadian Lepidoptera; by gift, the Blackmore collection of more than 2,100 Lepidoptera, the Quirsfeld collection of weevils numbering more than 1,100 specimens, and the M. R. Smith collection of ants approximating 15,000 specimens; a large collection of West Indian insects, about 60,000 specimens, collected with the aid of museum funds; by transfer, from various government agencies, numbering about 60,000 specimens, the greater part of which have come from the Bureau of Entomology and Plant Quarantine.

The addition of types for the year totalled 520. E. A. CHAPIN.

Late in the year the chairman of the joint committee had the opportunity of visiting many of the western institutions at which entomological collections are maintained. Nearly everywhere there was observed marked activity in the improvement of the collections through submission of material to specialists for classification, and through exchanges. However, local collecting groups are assembling vast quantities of material which cannot possibly be identified for a long time to come. In many groups of insects, which are especially well represented among the material obtained by general collecting, revisionary work will be required in order to establish a sound basis for proceeding with identification. That this situation is widely appreciated is evidenced by the increasing interest exhibited in the promotion of critical taxonomic studies.

The widespread adoption of the tray system in entomological collections was especially striking. Most institutions are unable, because of insufficient funds, to make a complete and rapid change in this direction, but at nearly all of those

which were visited at least an appreciable beginning has been made and there are definite plans for extension.

Of particular interest is the apparently growing recognition of the desirability of depositing type material in the larger, better established museums, and other public institutions, where proper care is assured for the future. This procedure, in addition to safeguarding the types, will greatly facilitate the work of students on given groups by bringing the type material together into a relatively small number of repositories.

Respectfully submitted by the joint committee.

H. H. KNIGHT, C. P. ALEXANDER,
FRANK E. LUTZ, JOSEF KNULL,
W. J. BROWN, T. H. FRISON,
E. C. VAN DYKE, C. F. W. MUESEBECK, *Chairman.*

REPORT OF THE COMMITTEE ON THE PROMOTION OF OFFICIAL ENTOMOLOGY

During the past year inquiries were made regarding suggested changes in federal appropriations for entomological work, and there has not seemed to be any occasion when formal action of this committee was indicated.

It seems proper in this report to call attention of the Executive Committee and others interested to the proposed balancing of the federal budget. The danger to the more important lines of entomological work seems to lie in the possibility that in reducing appropriations, there may be a reduction in certain vital items, even to the point of their elimination, in order that some less vital governmental activity, either in or outside the Bureau of Entomology and Plant Quarantine, may be supported. This may therefore mean that the committee will have important work to do in preserving the integrity of the work, maintaining the most useful and important lines of investigation and regulation and in preserving the organization of the Bureau itself from further proposals of reorganization which might be seriously detrimental. While at present we are faced only with a possibility, it seems proper to call attention to the fact that this committee should be suitably empowered to hold meetings and to make essential expenditures if and when such actions may be indicated by the discussions of appropriation bills. Attention should further be called to the fact that this committee is formed to serve both the entomological organizations, so that suitable authority is needed from both bodies.

Respectfully submitted,

E. F. PHILLIPS, *Chairman,*
J. J. DAVIS,
T. J. HEADLEE.

REPORT OF THE COMMITTEE ON RESOLUTIONS

1. WHEREAS, the Entomological Society of America has noted with deep regret the loss by death of the following members during the year: H. L. BOWERS, LAWRENCE BRUNER, P. W. CLAASEN, C. R. CROSBY, PHILIP DOWELL, SIGMUND GRAENICHER, VERNON L. KELLOGG, L. C. MARSTON, JR., FRANK J. PSOTA, MRS. ELLEN ROBERTSON-MILLER, and WILLIAM M. WHEELER,

Therefore, be it Resolved, that the Society at this, its Thirty-second Annual Meeting express its keen sense of loss and its real sorrow occasioned by the passing of these members, and order that this resolution be spread upon the minutes of this meeting and that it be printed in the ANNALS and a copy sent to the families of the deceased.

2. WHEREAS, the success of the Thirty-second Annual Meeting of the Entomological Society of America has been due in large part to the excellent work of the joint committee on arrangements of the Entomological Society of America and the American Association of Economic Entomologists,

Therefore, be it Resolved, that the thanks of the Society be extended to this joint committee headed by FRANK WALLACE, J. J. DAVIS and E. V. WALTER, in providing the fine facilities for the conduct of these meetings.

3. WHEREAS, the affairs of our organization have been so splendidly administered by the officers of the Society during the past year,

Therefore, be it Resolved, that the Society gratefully acknowledge the untiring services of its officers during this past year and extend them the thanks of the members for the fine spirit and splendid leadership which they have manifested in carrying out the duties of their respective offices.

4. WHEREAS, Professor P. J. PARROTT, of the New York State Agricultural Experiment Station, Geneva, N. Y., kindly consented to deliver the Annual Public Address,

Therefore, be it Resolved, that the Society extend its sincere thanks to Professor PARROTT for his most interesting and instructive address given on Wednesday Evening, December 29, 1937.

5. WHEREAS, Miss DESSA BYRD, organist, H. R. PAINTER, accordionist, and the STEPHEN FOSTER QUARTETTE furnished the two entomological societies most delightful entertainment on the occasion of the Entomologists' Dinner and the Annual Public Address,

Therefore, be it Resolved, that the Society express its thanks to MISS BYRD, MR. PAINTER, and the STEPHEN FOSTER QUARTETTE for the enjoyable music which they provided on those occasions.

6. WHEREAS, for twenty-seven years MR. JOHN D. SHERMAN, JR., has served the entomologists of America by the publication of catalogues and personal courtesies, and WHEREAS, the Entomological Society of America has never expressed any acknowledgment of these services and courtesies,

Therefore, be it Resolved, that the Society extend a vote of thanks to MR. SHERMAN for his continued interest in and assistance to entomologists.

7. WHEREAS, the HOTEL LINCOLN has provided excellent facilities for our meetings in Indianapolis,

Therefore, be it Resolved, that the Society express to the Management of the HOTEL LINCOLN its appreciation of the courtesies and services of that hotel enjoyed at this meeting.

Respectfully submitted,

W. D. FUNKHOUSER, *Chairman*,
ARTHUR GIBSON,
WM. P. HAYES.

The Society voted to amend Article IX of the Constitution by substituting the following for Section 1: "This constitution may be altered or amended in the following manner and subject to the following provisions: (1) a copy of the proposed alteration or amendment must be presented at a regular annual business meeting of the Society; (2) within six months after the meeting at which such alteration or amendment is presented the Secretary shall send to each member of the Society a suitable ballot to be marked, signed and returned to the Secretary prior to the following annual meeting; (3) the returned ballots shall be presented at said following meeting; (4) to effect the proposed alteration or amendment two-thirds of the returned ballots must favor it."

PRESIDENT O. A. JOHANNSEN reported the results of the mail referendum regarding the increase of the annual dues of the Society to $4.00 as follows:

Total membership in 1936	923
Total vote cast by December 23, 1937	636
Voting for an increase in dues	498
Not voting on the increase	24
Voting for no increase	114
Not resigning because of increase	530
Will resign if dues are increased	41
Will probably resign	11
Making no comment on resigning	45
Votes not received by December 23, 1937	287

The Executive Committee had recommended the increase to the Society in the report of its activities given by the Secretary, and the Society had previously adopted the recommendation.

DR. A. R. SHADLE gave a brief explanation of the travel arrangements available to members who wish to attend the International Congress of Entomology to be held in Berlin, Germany, in August, 1938. Members of the Society have already been circularized regarding this. Those wishing further information should communicate with Dr. A. R. Shadle, 143 University Ave., Buffalo, N. Y., or Dr. J. C. Bradley, Dept. of Entomology, Cornell University, Ithaca, N. Y.

Following the transaction of the above business, the meeting adjourned.

The following exhibits were on display in rooms near the meeting place of the Society.

1. New Mexican Gall Wasps. ALFRED C. KINSEY, University of Indiana, Bloomington, Ind.

2. Past Presidents of the Entomological Society of America, and the American Association of Economic Entomologists. J. J. DAVIS, Purdue University, Lafayette, Ind.

3. A Portable Mercury-vapor Collecting Light. Insect Survey Section, Illinois Natural History Survey, Urbana, Ill.

4. Nesting and Other Habits of the South American Leaf-cutting Ant, *Atta cephalotes*. NEAL A. WEBER, University of North Dakota, Grand Forks, N. D.

5. Entomological Philately. B. ELWOOD MONTGOMERY and HARRY E. BROWN, Purdue University, Lafayette, Ind., and University of Missouri, Columbia, Mo.

6. Improvements and New Technique Used in the Study of Insects. RICHARD LEWIS POST, Ward's Natural Science Establishment, Rochester, N. Y.

7. Dimorphism in the Female Bee (*Apis mellifica*). R. M. MELAMPY, Southern States Bee Culture Laboratory, Baton Rouge, La.

8. Three Entomological Book Plates. CLARENCE H. KENNEDY, Ohio State University, Columbus, Ohio.

Respectfully submitted,

CLARENCE E. MICKEL, *Secretary.*

BOOK NOTICES

A TEXTBOOK OF PLANT VIRUS DISEASES by KENNETH M. SMITH. Pages i-x and 1–615, 101 text figs. 1937. P. Blakiston's Son & Co., Inc., 1012 Walnut St., Philadelphia, Penna. Price $5.00.

The author is located at the English Potato Virus Research Station and is also on the staff of the Molteno Institute, Cambridge. The volume is a compendium of plant virus diseases, their identifications, distribution, etc. "The classification adopted in this book, consists of a grouping together of all those viruses which are chiefly associated with a particular host plant, and the viruses are then numbered 1, 2, 3, etc. The book follows a common plan; the virus is first dealt with; its properties, mode of transmission, etc., are given, and then the diseases it causes, arranged according to plant families, are described. * * * The insect vectors are described in some detail in a separate section."

Of the nine chapters, No. 8 is devoted to "Insects, etc., Concerned in the Transmission of Plant Viruses." This is a chapter of 94 pages dealing with the known insect vectors of plant virus diseases. Outside of a few thryps and some tingids these are mostly leafhoppers and aphids.

The illustrations of insects are excellent line and stippled drawings, and of plant diseases are from photographs which reproduce well on the hard semi-glossy paper used.

This volume is companion to "Recent Advances in the Study of Plant Viruses" by Smith and Brooks, 1934. The earlier volume gives techniques, all the curious biological implications brought up by the studies of viruses, and is a review of the biology of plant viruses. The present volume describes the known plant virus diseases, their probable viruses and means of transmission.

As viruses are objectively unknown (except perhaps in the case of that of tobacco mosaic) they are dealt with wholly by their effects. They are described and classified indirectly by the diseases they produce. This situation gives a sense of vagueness to any work on viruses. Such writing, while the best possible under the circumstances, recalls to this reviewer the sensations he had as a boy in trying to read some of the religious writers who gave detailed descriptions of the Deity as based on accounts of his activities as set forth in holy writings. Fortunately for students of viruses their statements can be checked.

Dr. Kenneth M. Smith's reputation is sufficient guarantee of the high quality of the work.—C. H. K.

THE MICROTOMISTS' VADE-MECUM (BOLLES LEE), Tenth Edition by J. BRONTE GATENBY and THEOPHILUS S. PAINTER. Pages i-xi and 1–784, 11 illustrations including a portrait of the original author, Arthur Bolles Lee. P. Blakiston's Son & Co., Inc., 1012 Walnut St., Philadelphia, Penna.

This is the latest edition of "Lee's Vade-Mecum" which has been the main standby in British and American laboratories since the first edition appeared in 1885. It is divided into three parts: Part I, pp. 1-232, 22 chapters, deals with the general principles and methods of fixation, sectioning, staining and mounting. Part II, pp. 233–619, 23 chapters, deals with many special techniques. Part III, pp. 620–728, 9 chapters, deals with botanical technique.

This is the first time the "Vade-Mecum" has reviewed botanical technique. The change is on trial. The publishers and authors believe it will be more widely useful and will be of even more value to zoologists as it will bring to their notice excellent methods developed in botanical laboratories.

Arthur Bolles Lee died as the ninth edition was going to press. Thus "It is fitting that some account of Arthur Bolles Lee should be given in this work. The Vade-Mecum appeared in 1885 when he was thirty-six years of age, and during the time that he was an assistant at the Russian laboratory at Villefranche, near Nice. * * * Lee was born at Coldrey House in Hampshire in 1849, and when he was eighteen he was articled to a London solicitor. On his mother's death in 1871 his inheritance enabled him to do as he liked—he broke his articles, became a

medical student in London but did not complete his course; he drifted to Switzerland and attended classes at the University of Neuchatel. He married a Swiss lady and spent the rest of his life in that country."

"Between the recent editions and those (I–VII) of Bolles Lee himself is this difference—Lee tried every method himself." This last remark in the preface probably accounts for the reliability of the Vade-Mecum as a laboratory guide in microtechnique. In the later editions the technical material has become so extensive and diverse that even the specialists responsible for various chapters have been unable to find time personally to check all methods quoted.

"Lee's Vade-Mecum" is indispensable in all zoological and entomological laboratories. Its fifty years of usefulness are its recommendation. It was started with a high ideal of service and has continued so to date.—C. H. K.

THE BOOK OF BIRDS, The First Work Presenting in Full Color All the Major Species of the United States and Canada, edited by Gilbert Grosvenor and Alexander Wetmore, 2 Vols., 4to, with a total of 738 pages, including 204 pages of full color plates showing 950 birds. Published by the National Geographic Society, Washington, D. C. Price, $5.00.

Of the two Editors, Dr. Gilbert Grosvenor is President of the National Geographic Society while Dr. Alexander Wetmore is Assistant Secretary of the Smithsonian Institution. Thus this work has the full approval of the two institutions. The two volumes are composed of 37 articles covering the various groups of birds in color and brief description, covering habits and various interesting phases of bird life. Some appear to be from the National Geographic Magazine while others are rewrites of various government publications and some are entirely original. The most exciting feature is the series of 204 plates of bird portraits in color by Major Allan Brooks.

The quality of the series of articles composing the work is shown when we point out that nine articles are by Wetmore, five by A. A. Allen, ten by T. Gilbert Pearson while the names of Murphy, Major Allan Brooks, Kalmbach, and F. C. Lincoln appear in the list of authors.

As an editor interested in the costs of illustration, printing and binding, we do not understand how such a comprehensive work in such true colors can be given away at the price asked. When we add to this the quality of the text and illustrations we realize what the National Geographic Society is doing for bird lovers the country over. It is the latest and best on North American birds written in a popular style with technical terms omitted, and by the best of authorities. Identifications are wholly by the colored pictures. All keys and technical descriptions are omitted. Naturally the numerous subspecies are not discussed or even named.

The work carries very interesting articles on bird banding, bird migration and the study and recording of bird voices by the microphone and wax record, a study developed largely by Professor Allen of Cornell.

As a boy the first book purchased by the reviewer was a copy of Davie's "Nests and Eggs of North American Birds." His chum had a Coues' "Key." We grew up in country where wood ducks, mergansers, woodcocks and such nested, and, in season, where ducks and geese flocked by the thousands. We knew the birds but guessed at names from unillustrated books. Now that we have the books, we are living in an age of English sparrows, starlings and "city chicken" on a stick! We feel confused. The passing of the birds drags at our heart strings. We feel certain that "The Book of Birds" will do something in building up a sentiment for bird refuges and gunning with field glasses and camera. It is a magnificent effort by leaders among bird lovers.—C. H. K.

LIST OF MEMBERS

Entomological Society of America

(March, 1938)

In this list, which is arranged alphabetically. members are given in lower case type, Fellows in small caps and Honorary Fellows in capitals. The year of admission to membership is given before the name, and of election to Fellowship and Honorary Fellowship in parentheses following the address. Names of Life Members are indicated by asterisk (*) and the special field of work in italics. Ch. indicates Charter Member, 1906.

A

'27. ADAMS, C. F., State Board of Health, Jefferson City, Mo. (F. '29). *Diptera.*
'08. AINSLIE, C. N., 5009 Orleans Ave., Sioux City, Iowa. (F. '31). *Hymenoptera.*
10. ALEXANDER, CHARLES P., Massachusetts State College, Amherst, Mass. (F. '20). *Tipulidae.*
'33. Alexander, E. Gordon, Dept. of Biology, University of Colorado, Boulder, Colo. *Orthoptera.*
'13. Allee, W. C., Zoology Bldg., University of Chicago, Chicago, Ill. *Behavior.*
'25. Allen, H. W., 429 E. Indiana St., Moorestown, New Jersey. *Tiphiidae.*
'36. Allen, Merlin W., 232 No. Second W., Logan, Utah. *Aphididae.*
'32. Amos, John M., Department of Entomology, University of Delaware, Newark, Delaware. *Coccidae, Cerambycidae.*
'30. Anderson, Edwin J., Agri. Exp. Sta., State College, Pa. *Beekeeping.*
'29. Anderson, Lauren D., Virginia Truck Experiment Station, Norfolk, Va. *Gerridae.*
'37. Anderson, William H., Room 429, U. S. National Museum, Washington, D. C. *Coleopterous larvae.*
'37. Anduze, Paul, Direccion de Malariologia, Apartado Postal 1509, Caracas, Venezuela.
'32. Annand, P. N., Bureau of Entomology, Washington, D. C. *Aphids.*
'28. App, Bernard A., Box 132, Florala, Alabama.
'36. Argo, Virgil N., 545 W. 146th St., New York City, N. Y.
'23. Armstrong, T., Ent. Lab., Vineland Station, Ontario, Canada. *Scarabaeidae.*
'36. Ashton, Donald F., State College Station, Box 5592, Raleigh, N. C. *Culicidae.*
'37. Assmuth, Rev. Joseph, Fordham University, New York, N. Y. *Isoptera.*
'34. Au, Sung Hin, P. O. Box 3319, Honolulu, Hawaii. *Aphids.*
'29. Audant, Andre, S. N. P. A., Port-au-Prince, Haiti. *Chrysomelidae.*
'33. Auten, Mary, Ashland College, Ashland, Ohio. *Erythroneura.*
'33. Avinoff, A., Carnegie Museum, Pittsburgh, Pa. *Palearctic Rhopalocera.*

B

'18. Babcock, O. G., Box 407, Sonora, Texas. *Mallophaga, Anoplura.*
'37. Babers, Frank H., Research Center, Beltsville, Maryland.
'25. Babiy, P. Peter, Dept. of Entomology, Cornell University, Ithaca, N. Y. *Psammocharidae.*
'30. Back, E. A., Bur. Ent., U. S. Dept. Agric., Washington, D. C. *Asilidae, Aleyrodidae.*
'21. BAERG, W. J., University of Arkansas, Fayetteville, Ark. (F. '32). *Poisonous Arthropods.*
'32. Bailey, Harold L., Dept. of Agriculture, Montpelier, Vt.
'30. Bailey, J. W., Box 107, University of Richmond, Richmond, Va. *Reptilia.*
'11. BAKER, A. C., Laboratorio Entomologico, Calzada Tacuba 295, Colonia Anahuac, Mexico, D. F., Mex. (F. '29). *Aphididae, Aleyrodidae.*

'12. Baker, A. W., Ontario Agricultural College, Guelph, Ontario, Canada. *Mallophaga.*
'22. Baker, Howard, Box 424, St. Joseph, Mo. *Apple and Pecan Insects.*
'33. Baker, Wm. A., 1920 Parkwood Ave., Toledo, Ohio. *European Corn Borer.*
'36. Baker, Walter C., Bur. Ent. and Plant Quar., 8 Whippany Road, Morristown, N. J.
'28. Balch, R. E., Dom. Ent. Lab., Fredericton, New Brunswick, Canada. *Forest Insects.*
'20. Balduf, W. V., 308 Entomology Bldg., University of Illinois, Urbana, Ill. *Chalcidoidea, Decatoma.*
Ch. *BALL, E. D., Exp. Sta., University of Arizona, Tucson, Ariz. (F. '08). *Cicadellidae, Membracidae, Fulgoridae.*
'08. BANKS, NATHAN, Mus. Comp. Zool., Harvard University, Cambridge, Mass. (F. '14).
'37. Barber, George W., 56 Hillhouse Ave., New Haven, Conn.
Ch. BARBER, H. G., 2222 Q St., N. W., Washington, D. C. (F. '30). *Hemiptera.*
Ch. BARBER, H. S., U. S. National Museum, Washington, D. C. (F. '28). *Chrysomelidae.*
'23. Bare, Clarence O., Route 4, Box 17, Charleston, South Carolina. *Notonectidae.*
'29. Bare, O. S., 2325 N. 67th St., Lincoln, Nebr. *Formicidae.*
Ch. Barlow, John, State College, Kingston, Rhode Island. *Corrodentia.*
'26. BARNES, H. F., Rothamsted Exp. Sta., Harpenden, Herts, England. (F. '37). *Cecidomyiidae.*
'28. Barnes, O. L., Bur. of Ent. and P. Q., Tempe, Arizona. *Hemileuca, Anastaxus.*
'28. Barrett, R. E., Box 171, Saticoy, Calif. *Scarabaeidae of World.*
'35. Barrett, W. L., Jr., Box 509, Uvalde, Texas.
'18. Basinger, A. J., Citrus Exp. Sta., Riverside, Calif. *Calliphoridae.*
'31. Bates, Marston, Seksioni Antimalariak, Tirana, Albania. *Diptera, Trypetidae.*
'24. BEAMER, RAYMOND H., 1000 Missouri St., Lawrence, Kansas. (F. '34). *Homoptera, Cicadellidae.*
'34. Beck, Elmer W., 1920 Parkwood Ave., Toledo, Ohio. *Parasites European Corn Borer.*
'29. Bedard, W. Delles, Box 630, Coeur d'Alene, Idaho. *Scolytidae, Braconidae.*
'20. Bedford, Hugh W., Gov't. Ent., Agri. Research Serv., Ent. Sect., Wad Medani, Sudan, Africa.
'24. Beebe, Wm., 33 W. 67th St., New York, N. Y.
'25. Bell, Ernest L., 150–17 Roosevelt Ave., Flushing, N. Y. *Hesperiidae.*
'36. Bell, Vernon A., 11 Cottage St., Amherst, Mass. *Isoptera.*
'37. Bennett, William H., New York State College of Forestry, Syracuse, N. Y. *Scolytidae, Cerambycidae.*
Ch. Bentley, G. M., 406 Merrill Hall, University of Tennessee, Knoxville, Tenn.
'23. Benton, Curtis, Box 495, West Lafayette, Indiana.
'17. *BEQUAERT, JOSEPH C., Harvard Medical School, Boston, Mass. (F. '34). *Vespidae, Tabanidae.*
'09. Berger, E. W., State Plant Board, Gainesville, Fla. *Coccidae, Aleyrodidae.*
'36. Bergren, Leslie, Univ. High School, Univ. of Minnesota, Minneapolis, Minn.
'28. Berly, J. A., Div. Ent., Clemson College, So. Carolina. *Coccidae, Odonata.*
'34. Bess, Henry A., 56 Hillhouse Ave., New Haven, Conn. *Tachinidae.*
Ch. BETTEN, CORNELIUS, 3 The Circle, Ithaca, New York. (F. '37). *Trichoptera.*
'25. Bigger, J. H., 117 Old Agricultural Bldg., University of Illinois, Urbana, Ill. *Corn Insects, Sunflower Weevil.*
'30. Billings, Samuel C., Insecticide Testing Lab., Beltsville, Maryland. *Mothproofing.*
'31. Bilsing, S. W., College Station, Texas. *Cerambycidae.*
Ch. BIRD, HENRY, 600 Milton Road, Rye, N. Y. (F. '30). *Noctuidae, Papaipema.*
'26. Bird, R. D., Box 250, Brandon, Manitoba, Canada. *Orthoptera.*
Ch. BISHOPP, F. C., Bur. Ent., Washington, D. C. (F. '28). *Ixodoidea, Siphonaptera, Anoplura.*
'24. Bishop, Sherman C., Dept. Biol., University Rochester, Rochester, N. Y. *Arachnida.*

'25. Bissell, Theo. L., Experiment, Georgia. *Aphididae.*
'37. Blackburn, Norris D., Dept. of Zool. and Ent., Ohio State University, Columbus, Ohio. *Chrysomelidae.*
'13. BLACKMAN, M. W., Bureau of Entomology, Washington, D. C. (F. '37). *Scolytidae.*
'34. Blackwelder, Richard E., c/o U. S. National Museum, Washington, D. C. *Staphylinidae.*
Ch. BLAISDELL, F. E., SR., Lane Medical Library Bldg., Webster and Sacramento Sts., San Francisco, Calif. (F. '24). *Tenebrionidae, Melyridae.*
'28. Blanchard, R. A., Box 32, Urbana, Ill. *Corn Earworm.*
'32. Blanton, Franklin S., P. O. Box 786, Babylon, L. I., N. Y. *Trypetidae, Ortalidae.*
'25. BLATCHLEY, W. S., 1558 Park Ave., Indianapolis, Ind. (F. '26; H. F. '32). *Coleoptera, Heteroptera, Orthoptera.*
'30. Blauvelt, Helen Hayden, c/o Wm. Savey, Lake Rd., Ithaca, N. Y.
'28. Blauvelt, Wm. E., Comstock Hall, Cornell University, Ithaca, N. Y.
'37. Bleasdale, Gale Gates, 409 Eighth St., S. W., Le Mars, Iowa. *Rhynchophora.*
'29. Boesel, M. W., R. R. No. 2, Oxford, Ohio. *Chironomidae.*
'37. Bohart, Richard M., 1945 Yosemite Road, Berkeley, Calif. *Strepsiptera, Hymenoptera.*
'28. Borror, Donald J., Dept. of Zoology and Entomology, Ohio State Univ., Columbus, Ohio. *Odonata.*
'14. BOVING, ADAM G., U. S. Nat. Museum, Washington, D. C. (F. '29). *Coleopterous larvae.*
'33. Boyce, A. M., Citrus Exp. Sta., Riverside, Calif. *Trypetidae.*
'32. Boyd, Mark F., P. O. Box 793, Tallahassee, Florida. *Culicidae.*
Ch. BRADLEY, J. C., Cornell University, Ithaca, N. Y. (F. '14). *Campsomeris, Vespidae, Scoliidae.*
'19. Bradley, G. H., Box 491, Orlando, Fla. *Diptera, Culicidae.*
'37. Bradley, Wm. G., 1920 Parkwood Ave., Toledo, Ohio. *Tabanidae, Parasitic Hymenoptera.*
'23. Branch, Hazel E., 3756 East Douglas Ave., Wichita, Kansas. *Chironomidae larvae.*
'25. Brandhorst, Carl T., Box 90, Sylvan Grove, Kansas. *Wasps.*
'34. Brannon, Lloyd W., 124 Virginia Ave., Ingleside, Norfolk, Va. *Mexican Bean Beetle, Vine-borer.*
Ch. BRAUN, ANNETTE F., 2702 May St., Cincinnati, Ohio. (F. '24). *Microlepidoptera.*
'26. Breakey, E. P., Mellon Institute, Pittsburgh, Pa. *Fulgoridae, Cicadellidae.*
'37. Breland, Osmond F., Dept. of Ent., North Dakota State College, Fargo, N. D. *Callimomidae.*
'30. Brennan, J. M., Box 508, Screw Worm Research Lab., Valdosta, Ga. *Tabanidae, Muscoidea.*
'29. Brindley, T. A., Box 73, Moscow, Idaho. *Pea Weevil.*
'33. Briscoe, M. S., 414 No. Kent St., Winchester, Va. *Culicidae, Simuliidae, Stomaxyidinae.*
'26. BRITTAIN, W. H., McDonald College P. O., Quebec, Canada. (F. '37). *Homoptera.*
Ch. BRITTON, W. E., Agricultural Exp. Station, New Haven, Conn. (F. '14). *Aleyrodidae, Coccidae.*
'20. BROMLEY, STANLEY W., High Ridge Road, Stamford, Conn. (F. '37). *Asilidae.*
'33. Brown, F. Martin, Fountain Valley School, Colorado Springs, Colo. *Pieridae of the Americas.*
'26. Brown, W. J., Ent. Branch, Dept. Agri., Ottawa, Canada. *Elateridae.*
Ch. BRUES, C. T., Biological Laboratory, Harvard University, Cambridge, Mass. (F. '14). *Hymenoptera.*
'30. BRUNER, S. C., Estacion Agronomica, Santiago de las Vegas, Havana, Cuba. (F. '37). *Homoptera, Hemiptera of Cuba.*
'27. Brunson, M. H., Box 150, Moorestown, N. J. *Parasites of Oriental Fruit Moth.*
'33. Bryant, Elizabeth B., Mus. Comp. Zool., Cambridge, Mass. *Arachnida.*
'30. Bryant, Owen, Box 4035, Tucson, Ariz. *Diptera, Coleoptera.*

'23. Bryson, Harry R., Dept. Ent., K. S. C., Manhattan, Kansas. *Elateridae, Scarabaeidae.*
'27. Buckell, Edward R., Box 308, Vernon, Brit. Col., Canada. *Orthoptera.*
Ch. *Bueno, J. R. De La Torre, 311 E. 4th St., Tucson, Ariz. (F. '28). *Aquatic Hemiptera, Heteroptera.*
'31. Bugbee, Robert E., Dept. Biology, College of Emporia, Emporia, Kansas. *Eurytomidae.*
Ch. Burgess, A. F., 20 Sanderson St., Greenfield, Mass. (F. '17). *Carabidae.*
'35. Burks, B. de W., 1209 W. Illinois St., Urbana, Ill. *Chalcididae.*
'27. Burrell, R. W., P. O. Box 47, Yokahama, Japan. *Thynnidae, Tiphiidae.*
'29. Bushey, Clinton J., Olivet College, Olivet, Ill. *Curculio.*
'33. Bushnell, Ralph J., Dept. of Zoology, Univ. of Georgia, Athens, Georgia. *Conopidae.*
'35. Bussart, J. Everett, 318 East Indiana Ave., Wheaton, Ill. *Tachinid Biology.*
'29. Butcher, Fred D., U. S. Bur. of Ent., Bozeman, Montana.
'32. Butcher, F. Gray, State College Station, Fargo, North Dakota.
'28. Butler, H. G., U. S. Bureau of Entomology, Box 424, St. Joseph, Mo.
'30. Butt, F. H., Cornell University, Ithaca, N. Y.
'20. Buys, John L., Dept. Biol., St. Lawrence University, Canton, N. Y. *Homoptera, Cicadellidae.*
'36. Buzicky, Albert W., 487 St. Clair St., St. Paul, Minn. *Chyphotes.*
'24. Byers, C. Francis, Dept. Biol., Univ. Florida, Gainesville, Fla. *Odonata.*

C

'25. Caffrey, D. J., Bureau of Entomology, Washington, D. C.
'35. Caldwell, John S., Ohio Biological Survey, Ohio State University, Columbus, Ohio. *Chermidae.*
Ch. Calvert, Philip P., Zool. Lab., Univ. of Pennsylvania, Philadelphia, Penn. (F. '07). *Odonata.*
'28. Campbell, Frank Leslie, Dept. of Zool. and Ent., Ohio State University, Columbus, Ohio. (F. '34). *Toxicology.*
'13. Campbell, Roy E., P. O. Box 287, Alhambra, California.
'14. *Capp, S. B., Box 2054, Philadelphia, Penn.
'33. Carpenter, F. M., Mus. Comp. Zool., Harvard University, Cambridge, Mass. *Mecoptera, Neuroptera.*
'26. Carpentier, Fritz, Inst. Ed. Van Veneden, 10 Rue Vivegnis, Leige, Belgium. *Morphology.*
'31. Carruth, Laurence A., Div. Ent., N. Y. State Exp. Sta., Geneva, N. Y. *Meloidae.*
'22. Carter, Walter, P. O. Box 3166, Honolulu, T. H. *Insect transmission of plant diseases.*
'26. Cartwright, O. L., Agri. Exp. Station, Clemson College, Clemson College, S. C. *Scarabaeidae.*
'26. Cartwright, William B., P. O. Box 1857, Sacramento, California. *Hessian Fly.*
'17. Cassidy, Thomas P., Box 1910, Tucson, Arizona. *Cotton Insects.*
'29. Cecil, R., P. O. Box 1330, Ventura, California. *Bean Insects.*
'29. Cendana, S. M., Agricultural College, Laguna, P. I. *Coccinellidae.*
'22. Chamberlin, Joseph C., P. O. Box 248, Corvallis, Oregon. *Chelonethida.*
Ch. Chamberlin, R. V., Univ. Utah, Salt Lake City, Utah. (F. '17). *Myriopoda, Arachnida.*
'18. Chambers, Ernest L., Room 9, W. Wing, State Capitol, Madison, Wisconsin.
'14. Champion, H. G., Forest Research Inst., Dehra Dun, U. P. India. *Coleoptera.*
'15. Chapman, James W., Silliman Inst., Dumaguete, Philippine Is. *Ants of P. I.*
'14. Chapman, Royal N., Univ. of Hawaii, Honolulu, Hawaii. (F. '27). *Ecology.*
'13. Childs, Leroy, Hood River, Oregon. *Apple and Pear Insects.*
'30. Christenson, Leroy D., Bureau of Entomology and P. Q., c/o Citrus Exp. Station, Riverside, Calif. *Aptera, Myriapoda.*
'28. Christenson, Mrs. Reed O., Dept. Zool., Univ. of Minn., Minneapolis, Minn.
'27. Clagg, C. F., Barnstable, Mass. *Mecoptera, Hemiptera.*

'22. Clark, Chas. A., Box 150, Moorestown, New Jersey. *Hymenopterous parasites.*
'30. Clarke, Wm. H., Box 69, Thomaston, Georgia. *Orthoptera, Lepidoptera.*
'34. Clarke-Macintyre, William, Prov. de Tungurahua, Zatzayacu Banos, Rep. del Ecuador, S. A. *Field collector.*
'14. CLAUSEN, CURTIS P., Bur. Entomology, Washington, D. C. (F. '37). *Insect Parasites.*
'07. COCKERELL, T. D. A., 908 Tenth St., Boulder, Colo. (F. '08; H. F. '37). *Bees, Fossil Insects.*
'16. Cole, F. R., P. O. Box No. 6, Redlands, Calif. *Diptera, Hymenoptera.*
'16. Collins, C. W., Bureau of Ent. and Plant Quar., 8 Whippany Road, Morristown, New Jersey. *Insect vectors of Dutch Elm Disease.*
'29. Collins, Donald L., Dept. of Ent., Cornell University, Ithaca, N. Y. *Codling Moth, Dutch Elm Disease Insects.*
'21. Colman, Wallace, 236 Madison St., N. W., Washington, D. C.
'21. Compton, Chas. C., Floriculture Bldg., Urbana, Ill. *Greenhouse and Truck Insects.*
'29. Conklin, J. G., Dept. Ent., University of New Hampshire, Durham, N. H. *Coccinellidae, Syrphidae.*
'35. Connell, Walter A., Box 732, Dover, Delaware. *Diptera.*
Ch. Cook, Mel T., Insular Exp. Sta., Rio Piedras, Porto Rico. *Entomogenous Fungi.*
'19. Cook, Wm. C., Box 642, Modesta, Calif. *Noctuidae.*
'10. COOLEY, R. A., U. S. Public Health Service, Hamilton, Mont. (F. '24). *Ixodidae, Ixodiphiginae.*
'36. Cooper, James Furman, Box 965, Salisbury, North Carolina. *Japanese Beetle.*
'37. Corkran, W. S., Mosquito Control Commission, Lewes, Delaware. *Mosquitoes.*
'36. Coronel, Arsenio Y., Agri. College, Laguna Province, Philippine Islands. *Trypetidae.*
'32. Cory, Ernest N., State Entomologist, College Park, Maryland.
'21. Costa-Lima, Angelo M. da, Instituto Oswaldo Cruz., Caixa Postal—926, Rio de Janeiro, Brazil. *Economic Entomology.*
'15. COTTON, RICHARD T., 343 No. 14th St., Manhattan, Kansas. (F. '37). *Curculionid larvae.*
'35. Couture, Philip G., 73 Baldwin St., Laconia, New Hampshire.
'11. *CRAMPTON, G. C., 86 Pleasant St., Amherst, Mass. (F. '17). *Morphology.*
'36. Crandall, Herbert A., Dept. Ent., Ohio State University, Columbus, Ohio. *Insecticides.*
'34. Crawford, Wiley William, Care of Blackburn College, Carlinville, Ill.
'33. Creighton, John T., Univ. of Florida, Gainesville, Fla. *Economic Entomology.*
Ch. CRESSON, E. T., JR., 11 Amherst Ave., Swarthmore, Penn. (F. '24). *Ephydridae, Micropezidae.*
'34. Cross, Derek Harold, 129 56th St., Niagara Falls, N. Y.
'15. CURRAN, C. H., Am. Mus. Nat. Hist., 77th St., Central Park W., New York, N. Y. (F. '34). *Diptera.*
'21. Cutright, Clifford R., Agri. Exp. Sta., Wooster, Ohio. *Aphidae.*

D

'35. Daggy, Richard H., Div. of Entomology, University Farm, St. Paul, Minn. *Ephemerida.*
'38. Dahm, Paul A., 502 East John St., Champaign, Ill.
'32. Daniel, Derrill M., New York Agri. Exp. Sta., Geneva, N. Y. *Ichneumonidae, Braconidae.*
'29. Darley, Merrill M., P. O. Box 149, Long Island City, N. Y. *Insecticides.*
'25. Darlington, P. J., Jr., Mus. Comp. Zool., Cambridge, Mass. *Adephaga, Dryopidae.*
'30. Davidson, Ralph H., Dept. Ent., Ohio State University, Columbus, Ohio. *Cicadellidae.*
'13. Davidson, Wm. M., Insecticide Section, Beltsville, Maryland. *Insecticides.*
'27. Davis, A. C., Bur. of Ent. and Plant Quar., Beltsville Research Center, Beltsville, Md. *Coleoptera, Rhyncophora.*

'36. Davis, Clifton J., 1108 24th St., Ogden, Utah. *Scolytidae.*
'22. Davis, E. W., Box 334, St. George, Utah. *Cicadellidae.*
Ch. DAVIS, J. J., Purdue University, Lafayette, Ind. (F. '17). *Aphididae, Lachnosterna.*
Ch. *DAVIS, WM. T., 146 Stuyvesant Place, Staten Island, N. Y. (F. '17). *Cicadidae, Orthoptera.*
'13. DEAN, GEO. A., K. S. C., Manhattan, Kansas. (F. '17). *Economic Entomology.*
'33. Dean, R. W., Box 51, Vassar College, Poughkeepsie, N. Y. *Trypetidae.*
'36. Dearolf, Kenneth, 71 Park Road, Wyomissing Hills, West Lawn, Pa. *Cave Insects.*
'25. Deay, Howard O., Dept. Ent., Purdue University, Lafayette, Ind. *Coreidae, Tenagobia, Micronecta.*
'24. Decker, Geo. C., Dept. Zool. and Ent., Iowa State College, Ames, Iowa. *Stalk Borers, Crambus.*
'24. DeCoursey, R. M., Connecticut Agri. College, Storrs, Conn. *Hemiptera.*
'29. DeLeon, Donald, 330 Hilgard Hall, U. C., Berkeley, Calif. *Scolytidae.*
'14. DELONG, D. M., Dept. Ent., Ohio State Univ., Columbus, Ohio. (F. '30). *Cicadellidae.*
'36. Del Ponte, Edward, Instituto Bacteriologico, Calle Velez Sarsfield 563, Dept. Nac. de Hygiene, Buenos Ayres, Argentine. *Parasitic Insects.*
'31. Denis, J. R., Laboratoire de Zoologie, Faculte des Sciences, Univ. of Dijon, (Cote d'Or), France. *Apterygota.*
'34. Denning, Donald G., Div. of Ent., Univ. of Minnesota, St. Paul, Minn. *Trichoptera, Corethrinae.*
'37. Dennis, Clyde A., Tusculum College, Greenville, Tenn.
'34. Deonier, C. C., Box 187, Tempe, Arizona. *Muscidae.*
'20. Detwiler, John D., Univ. Western Ontario, London, Ont., Canada. *Corn Borer Prob.*
'27. Dicke, Ferdinand F., Arlington Farm, Arlington, Va. *Harmolita Parasites.*
'34. Dickinson, Clifford L., 804 East Jackson St., Freeport, Ill.
'22. Dietrich, Henry, 1086 North Broadway, Yonkers, N. Y. *Coleoptera.*
'35. Dillon, Lawrence Samuel, 316 Woodside Ave., West Lawn, Penn.
'24. Dills, L. E., Exp. Sta. Bldg., State College, Penn.
'26. Dirks, C. O., Dept. Bot. and Ent., Orono, Maine. *Biology of Lepidoptera.*
'31. Ditman, L. P., Univ. Maryland, College Park, Maryland. *Tingidae.*
'27. *Doak, K. D., Dept. Bot., Univ. Pennsylvania, Philadelphia, Penn. *Gelechiidae.*
Ch. DOANE, R. W., Stanford Univ., California. (F. '24).
'28. Dobbins, Traber N., Japanese Beetle Lab., Moorestown, N. J. *Pecan Phylloxera.*
'36. Dodge, Harold R., Div. of Ent., Ohio State University, Columbus, Ohio. *Scolytidae.*
'22. DOERING, KATHLEEN C., Dept. Ent., Univ. of Kansas, Lawrence, Kans. (F. '35). *Homoptera.*
'28. Doner, Melvin H., The J. R. Watkins Co., 150–178 Liberty St., Winona, Minn. *Chalcids.*
'31. Donohoe, Heber C., P. O. Box 1, Trenton, N. J. *Pyralidae.*
'30. Dornfeld, Ernest J., School of Medicine, Univ. of Oklahoma, Oklahoma City, Okla. *Haploa, Hymenoptera.*
'37. Dorst, Howard E., Utah Agri. College, Logan, Utah. *Cicadellidae.*
'22. Doucette, Chas. F., Box 458, Sumner, Wash. *Ornamental Insects.*
'23. Douglass, J. R., Box 1100, Twin Falls, Idaho. *Chrysomelidae.*
'28. Dove, W. E., 1010 Travis Bldg., San Antonio, Texas. *Animal Parasites.*
'31. Dow, Richard, New England Museum of Natural History, 234 Berkeley St., Boston, Mass. *Sphecoid Wasps.*
'22. Dowden, Philip B., 56 Hillhouse Ave., New Haven, Conn. *Parasitic Hymenoptera.*
'22. DRAKE, CARL J., Iowa State College, Ames, Iowa. (F. '31). *Tingitidae.*
'37. Dreisbach, Robert R., 806 Mill St., Midland, Michigan. *Vespidae.*
'31. Driggers, Byrley F., Agri. Exp. Sta., New Brunswick, N. J. *Economic Entomology.*
'26. Dunavan, David, Clemson College, South Carolina. *Haliplidae.*

'23. Duncan, Carl D., Box 4, Stanford University, Calif. *Vespidae, Bembicidae.*
'28. Dunnam, E. W., Box 8, Leland, Miss. *Cotton Resistance to Insects.*
'16. DuPorte, E. Melville, Macdonald College, Quebec, Canada. *Diptera, Ixodoidea.*
'14. Dusham, E. H., Dept. Zool. and Ent., State College, Penn. *Coleoptera.*

E

Ch. Easton, Norman S., 458 High St., Fall River, Mass. *Coleoptera.*
'31. Eckert, J. E., Box 381, Davis, Calif. *Beekeeping.*
'36. Eddy, Brayton, 52 Taber Ave., Providence, R. I.
'23. EDDY, C. O., Louisiana Exp. Station, Baton Rouge, Louisiana. (F. '31).
Ch. Edwards, Edwin H., 1548 Rockway Ave., Lakewood, Ohio.
'31. Elliott, D. C., Southwestern Louisiana Institute, Lafayette, La. *Aphids.*
'34. Ellisor, L. O., Agri. Exp. Station, Univ. of Louisiana, Baton Rouge, La. *Noctuidae.*
'24. Elmore, J. C., Box 287, Alhambra, Calif. *Truck Crop Insects.*
'27. Elson, J. A., Gustavus Adolphus College, St. Peter, Minn. *Hemiptera.*
'36. Elster, Oscar G. R., 1000 Ivy St., St. Paul, Minn.
'11. Ely, Chas. R., 6 Kendall Green, Washington, D. C. *Gracilariidae.*
'19. EMERSON, ALFRED E., Dept. Zool., Univ. Chicago, Chicago, Ill. (F. '37). *Isoptera, Termitophiles.*
'25. Enders, Howard E., 249 Littleton St., West Lafayette, Ind. *Mallophaga.*
Ch. ENGELHARDT, GEORGE P., 28 Club Way, Hartsdale, N. Y. (F. '32). *Aegeriidae.*
'10. ESSIG, E. O., Univ. of California, Berkeley, Calif. (F. '26). *Aphididae, Coccidae.*
'29. Evans, J. Harwood, Oshkosh High School, Oshkosh, Wisc. *Phymatidae.*
'30. Everly, Ray T., Holmesville, Holmes Co., Ohio. *Carabidae.*
'10. EWING, HENRY E., U. S. Nat. Museum, Washington, D. C. (F. '28). *Acarina.*
'18. Eyer, John R., State College, New Mexico. *Cicadellidae, Chermidae.*

F

'32. Fairchild, Graham Bell, Caixa Postal H. 9, Rio de Janeiro, Brazil. *Culicidae, Tabanidae.*
Ch. FALL, HENRY C., Tyngsboro, Mass. (F. '07). *Coleoptera.*
'35. Falls, Olive, c/o American Lumber & Treating Co., 37 West Van Buren, Chicago, Ill. *Termite Biology.*
'30. Farquhar, Donald W., 296 Ames St., Lawrence, Mass. *Lepidoptera of New England.*
'31. Farrar, M. D., State Ent. Bldg., Urbana, Ill. *Economic Entomology.*
'17. Fattig, P. W., Box 788, Emory University, Ga.
'34. Fay, Richard William, Dept. of Ent., Univ. of Illinois, Urbana, Ill. *Morphology, Physiology.*
Ch. FELT, E. P., Bartlett Tree Research Lab., Stamford, Conn. (F. '08). *Gall midges.*
'30. Feng, Hsiao-Tang, 9 Chen Hong, Wushih, Kiangau, China. *Dytiscidae.*
'36. Fenton, Alfred S., 1103-04 Second National Bank Bldg., Houston, Texas.
Ch. FERNALD, H. T., 707 East Concord Ave., Orlando, Fla. (F. '14; H. F. '37). *Sphecidae.*
'14. FERRIS, G. F., Natural History Museum, Stanford Univ., Calif. (F. '34). *Coccidae, Mallophaga, Anoplura, Diptera.*
'27. Ficht, George A., State Corn Borer Station, Auburn, Indiana. *Noctuidae.*
'35. Field, William D., 325 Indiana St., Lawrence, Kansas. *Lepidoptera.*
Ch. Field, Wm. L. W., Milton Academy, Vose's Lane, Milton, Mass.
'31. Filmer, Robert Sterling, Rutgers University, New Brunswick, N. J. *Insecticides, Bees.*
'27. Fisher, C. K., 712 Elizabeth St., Fresno, Calif. *Stored product insects.*
'35. Fisher, Elizabeth G., 20 Blythewood Road, Roland Park P. O., Baltimore, Maryland. *Odonata, Mycetophilidae, Insect Morphology.*
'36. Fisk, Frank Wilbur, Dept. Ent., University Farm, St. Paul, Minn.

'30. FLANDERS, STANLEY E., Citrus Exp. Sta., Riverside, Calif. (F. '37). *Mymaridae.*
'31. Fletcher, Fred W., Biochem. Dept., Dow Chemical Co., Midland, Michigan. *Insecticides.*
'19. Fletcher, Robert K., Box 152, Faculty Exch., College Station, Texas. *Cicadellidae.*
'08. FLINT, WESLEY P., St. Ent. Bldg., Urbana, Ill. (F. '31). *Economic Entomology.*
'24. FLUKE, C. L., King Hall, Univ. of Wisconsin, Madison, Wis. (F. '35). *Syrphidae.*
'08. *FORBES, WM. T. M., Cornell Univ., Ithaca, N. Y. (F. '30). *Lepidoptera, Neuropteroids.*
'30. Foster, Charles E., Colgate Univ., Hamilton, N. Y. *Coccidae.*
'20. *Fournier, Mrs. Gaston, 90 Boul. Malesherbes, Paris 8, France. *Lepidoptera.*
'31. FOX, David E., Box 1100, Twin Falls, Idaho. *Ecology.*
'11. FRACKER, S. B., Bureau of Ent. and Plant Quar., U. S. Dept. Agric., Washington, D. C. (F. '34). *Coreidae.*
'34. Frankenfeld, Justus C., Box 187, Las Vegas, New Mexico. *Ecology.*
'23. Freeborn, Stanley B., 101 Giannini Hall, Univ. of California, Berkeley, Calif. *Culicidae.*
'37. Freeman, Thomas N., Ent. Branch, Dept. of Agri., Ottawa, Ontario, Canada. *Lepidoptera.*
'22. Friend, Roger B., Agri. Exp. Sta., 153 Huntington St., New Haven, Conn. *Diptera.*
'14. FRISON, T. H., Nat. Hist. Bldg., Univ. of Illinois, Urbana, Ill. (F. '29). *Bremidae.*
Ch. Frost, C. A., 67 Henry St., Framingham, Mass. *Coleoptera.*
'14. FROST, STUART W., 465 E. Foster Ave., State College, Pa. (F. '35). *Agromyzidae, Hispinae.*
Ch. Fullaway, D. T., Board Agri., Box 3319, Honolulu, Hawaii. *Braconidae.*
'16. FULTON, B. B., State College, Raleigh, North Carolina. (F. '32). *Orthoptera.*
'11. FUNKHOUSER, WM. D., University of Kentucky, Lexington, Ky. (F. '20). *Membracidae.*

G

Ch. GAHAN, A. B., U. S. Nat. Museum, Washington, D. C. (F. '28). *Chalcidoidea.*
'16. Gaige, F. M., Mus. Zool., Univ. Michigan, Ann Arbor, Mich. *Formicidae.*
'28. Gamble, John T., 64 Eagle St., Greenville, Penn. *Aquatic Coleoptera.*
'37. Gardner, Theodore R., Bur. of Ent. and Plant Quar., Box 150, Moorestown, N. J. *Parasites.*
'22. Garlick, W. G. P., Vineland Station, Ontario, Canada. *Tenthredinoidea.*
'14. Garman, Philip. Agri. Exp. Sta., New Haven, Conn. *Odonata, Acarina.*
'30. Geissler, George H., State Exp. Farm, Kearneysville, West Virginia.
'16. Gentner, Louis G., 44 N. Orange St., Medford, Oregon. *Halticinae.*
Ch. Gerhard, Wm. J., Field Museum Nat. Hist., Chicago, Ill. *Hemiptera.*
'22. Gerry, Bertram I., Box 28, Wellesley Hills, Mass.
'32. Gertsch, Willis J., Am. Mus. Nat. Hist., 77th St. and Central Park W., New York, N. Y. *Arachnida.*
'32. Ghika, George de, Royal Consulate General of Hungary, London Woods, Holly Lane, Rye, N. Y. *Geometridae.*
Ch. GIBSON, ARTHUR, Dominion Entomologist, Ottawa, Ontario, Canada. (F. '17).
'14. Gibson, E. H., Trinity Episcopal Church, Galveston, Texas. *Hemiptera.*
Ch. GILLETTE, C. P., Agri. College, Fort Collins, Colo. (F. '07; H. F. '37). *Aphididae.*
'28. Gilliatt, F. C., Ent. Lab., Annapolis Royal, Nova Scotia, Canada. *Tortricidae.*
'21. Gilmer, Paul M., Coastal Plains Experiment Station, Tifton, Georgia.
'16. Glaser, R. W., Rockefeller Med. Res. Inst., Princeton, N. J. *Insect Diseases.*
'11. Glasgow, Hugh, Experiment Station, Geneva, New York.
'11. Glasgow, Robert D., State Education Bldg., Albany, N. Y. *Phyllophaga.*
'33. Glover, L. C., Box 486, T. Hall, Durham, N. H. *Carabidae, Cerambycidae.*

'30. Glover, Louise Haas, Box 486, T. Hall, Durham, N. H. *Carabidae.*
'30. Good, Newell E., 1204 Fremont St., Manhattan, Kansas. *Stored Products Coleoptera.*
'36. Gouck, Harry K., Fernald Hall, Massachusetts State College, Amherst, Mass. *Plecoptera.*
'31. Gould, Geo. E., Purdue University, Lafayette, Ind. *Rhagovelia, Semi-aquatic Hemiptera.*
'17. GRAHAM, SAMUEL A., University of Michigan, Ann Arbor, Mich. (F. '32). *Forest Insects.*
'22. GRANOVSKY, A. A., Div. Ent., University Farm, St. Paul, Minn. (F. '35). *Aphiidae.*
'25. Grant, U. S. IV, Nat. Hist. Museum, Balboa Park, San Diego, Calif.
'14. Greene, Chas. T., Box 182, College Park, Maryland. *Diptera.*
'24. Greer, A. H., 127 U. S. Court House, El Paso, Texas. *Heterocera, Culicidae.*
'36. Gressitt, J. Linsley, Rm. 112, Agri. Hall, Univ. of California, Berkeley, Calif. *Coleoptera.*
'34. Griffith, Melvin E., 310 Snow Hall, University of Kansas, Lawrence, Kans. *Alconeura, Collembola.*
'20. Griswold, Grace H., Dept. Ent., Cornell Univ., Ithaca, N. Y. *Aphididae.*
'36. Gross, James B., 323 East King St., York, Pa. *Collembola.*
'24. Gui, Harry L., Agri. Exp. Sta., Wooster, Ohio. *Vegetable Insects.*
'33. Gurney, Ashley B., Div. of Insect Identifications, Bur. of Ent., U. S. D. A., Washington, D. C. *Locustidae.*
'29. Guthrie, Howard E., 223 Welch Ave., Ames, Iowa. *Coccidae.*
'16. Guyton, T. L., 9 West Union Ave., Bound Brook, N. J. *Aphididae.*
'34. Gyger, May Katharyn, Dept. of Ent., Cornell Univ., Ithaca, N. Y. *Odonata.*

H

'25. Haber, Vernon R., 355 West Ridge Ave., State College, Penn. *Orthoptera.*
'27. *Hadden, Fred C., Midway Island, Pacific Ocean, U. S. A. *Histeridae, Cicindelidae.*
'23. Hadley, C. H., Bureau Entomology, Moorestown, N. J. *Japanese Beetle.*
'24. Haeussler, Gilbert J., U. S. D. A., P. O. Box 150, Moorestown, N. J. *Ichneumonidae, Braconidae.*
'14. Hagen, Harold R., Dept. Biology, College of the City of New York, N. Y. *Embryology.*
'37. Hagmann, Lyle E., R. 3, Hamilton Road, New Brunswick, N. J.
'25. Hall, David G., Bureau of Ent., Washington, D. C. *Sarcophagidae, Diptera.*
'21. Hallock, Harold C., Dept. of Ent., Cornell University, Ithaca, N. Y. *Sarcophagidae.*
'14. Hamilton, Clyde C., Rutgers College, Dept. Ent., New Brunswick, N. J.
'16. Hamlin, John C., 481 Federal Bldg., Salt Lake City, Utah. *Chelinidea.*
'36. Hammer, Oscar H., Box 51, Vassar College, N. Y. S. Agr. Exp. Sta., Poughkeepsie, N. Y.
'36. Hammond, Datus M., Dept. of Zool. and Ent., Utah State Agri. Coll., Logan, Utah. *Protozoan parasites of insects.*
'22. Hamner, A. L., Box 436, State College, Miss. *Aphididae, Phylloxera.*
'37. Handford, Richard H., Box 250, Brandon, Manitoba, Canada. *Acrididae.*
'37. Hardy, D. Elmo, Dept. of Entomology, Utah Agri. Coll., Logan, Utah. *Bibionidae, Sepsidae, and Therevidae.*
'36. Harmston, Fred Carl, Dept. of Ent., Utah State Agri Coll., Logan, Utah. *Dolichopodidae.*
'07. *HARNED, R. W., Bureau of Entomology, Washington, D. C. (F. '27).
'33. Harper, Lawrence C., Fort Jackson, N. Y.
'29. Harries, F. H., Box 1100, Twin Falls, Idaho. *Ecology, Physiology.*
'23. HARRIS, HALBERT M., Dept. Zool. and Ent., Iowa State College, Ames, Iowa. (F. '37). *Hemiptera.*
'21. Hartzell, Albert, Boyce Thompson Inst., Yonkers, N. Y. *Cicadellidae.*
'07. Hartzell, F. Z., Agri. Exp. Sta., Geneva, N. Y. *Economic Entomology.*
Ch. Haseman, Leonard, Univ. of Missouri, Columbia, Mo. *Psychodidae.*
'32. Haskins, Caryl P., 1188 Avon Road, Schenectady, N. Y. *Hymenoptera,* esp. *Formicidae.*

'20. Hatch, Melville H., Dept. Zool., Univ. Washington, Seattle, Wash. *Coleoptera.*
'32. Haub, James G., Ohio State University, Dept. of Zool., Columbus, Ohio. *Physiology.*
'30. Haug, Gordon W., Box 21, Cotaro, Arizona. *Formicidae.*
'27. Hawkins, J. H., Agri. Exp. Sta., Orono, Maine. *Elaterid and Noctuid larvae.*
'32. Hawley, I. M., P. O. Box 150, Moorestown, N. J.
'35. Haydak, M. H., Ent. Div., University Farm, St. Paul, Minn. *Honeybee nutrition.*
'19. HAYES, WM. P., Dept. Ent., University of Illinois, Urbana, Ill. (F. '29). *Larvae.*
Ch. HEADLEE, THOMAS J., Agric. Exp. Sta., New Brunswick, N. J. (F. '20).
'31. Heaton, Robert R., 1075 N. Linwood St., Indianapolis, Ind. *Fulgoridae, Homoptera.*
'34. Heiss, Elizabeth M., Dept. of Physiology., Colorado State College, Ft. Collins, Colorado. *Syrphidae, Culicidae.*
'34. Hendee, Esther C., Dept. Biology, Russell Sage College, Troy, N. Y *Isoptera, Hymenoptera.*
'32. Henderson, Chas. F., 291 Lincoln St., Twin Falls, Idaho. *Mymaridae, Pipunculidae.*
'31. Henderson, Lyman S., Dept. of Entomology, Univ. of Kansas, Lawrence, Kansas. *Curculionidae.*
'32. Henderson, W. W., Agri. Exp. Sta., Logan, Utah. *Oedipodinae, Orthoptera.*
Ch. HENSHAW, SAMUEL, 28 Fayerweather St., Cambridge, Mass. (F. '07).
'29. Hering, Paul E., Oglethorpe University, Georgia. *Economic Entomology.*
'25. HERMS, WM. B., 112 Agri. Hall, Univ. of California, Berkeley, Calif. (F. '29). *Med. Entomology.*
Ch. HERRICK, GLENN W., 219 Kelvin Place, Ithaca, N. Y. (F. '14). *Thysanoptera, Coccidae.*
'16. Hess, Walter N., Hamilton College, Clinton, N. Y.
'31. Hetrick, Lawrence A., Jr., c/o W. E. Anderson, State Entomologist, Box 590, Baton Rouge, La. *Coleoptera, Hemiptera.*
'28. Hickman, J. R., Normal College, Ypsilanti, Mich. *Haliplidae.*
'30. Hicks, Chas. H., P. O. Box 812, Burbank, Calif. *Triepeolus, Epeolus.*
'08. Hilton, Wm. A., 1263 Dartmouth Ave., Claremont, Calif. *Campodea, Japyx.*
'36. Hinkle, Galen A., Dept. Ent. and Zool., Colorado State College, Ft. Collins, Colo. *Orthoptera.*
'27. HINMAN, E. HAROLD, Division of Malaria Control, Tennessee Valley Authority, Wilson Dam, Alabama. (F. '37). *Culicidae.*
'33. Hinman, Frank G., P. O. Box 73, Moscow, Idaho. *Pea Weevil.*
'33. Hinton, Howard E., Dept. of Zool., Univ. of Cambridge, Downing St., Cambridge, England. *Dryopidae.*
'34. Hitchcock, John David, Intermountain Bee Culture Field Laboratory, Laramie, Wyo. *Bacteriology of Bee Diseases.*
'27. Hockenyos, Geo. L., 213 E. Jefferson St., Springfield, Ill.
Ch. Hodgkiss, H. E., Exp. Sta. Bldg., State College, Penn. *Eriophyidae.*
'29. Hodson, A. C., Div. Entomology, Univ. Farm, St. Paul, Minn. *Ecology.*
'14. *Hoffman, W. A., Sch. Trop. Med., San Juan, Porto Rico. *Biting Flies.*
'29. Hoffmann, Clarence H., Bureau of Ent. and Plant Quarantine, 8 Whippany Road, Morristown, New Jersey. *Scarabaeidae.*
'20. Hoffmann, Wm. E., Lingnan Univ., Canton, China. *Hemiptera.*
'35. Holway, Richard T., South Duxbury, Mass. *Termites.*
Ch. HOOD, J. DOUGLAS, Dept. Entomology, Cornell Univ., Ithaca, N. Y. (F. '32). *Thysanoptera.*
'37. Hopping, George R., Box 308, Vernon, Brit. Col., Canada. *Cerambycidae.*
'27. Hopping, Ralph, Box 308, Vernon, Brit. Col., Canada. *Cerambycidae.*
'34. Horsfall, William R., Dept. of Ent.-Zool., South Dakota State College, Brookings, S. D.
'13. Horton, J. R., 437 South Fountain Ave., Wichita, Kansas. *Phyllophaga, Formicidae.*
'34. Hoskins, W. M., 112 Agric. Hall, Univ. of California, Berkeley, Calif. *Physiology.*
'24. Hough, W. S., Winchester, Virginia. *Apple Insects.*

Ch. HOUSER, J. S., Agri. Exp. Sta., Wooster, Ohio. (F. '31). *Economic Entomology.*
Ch. HOWARD, L. O., Bur. Ent., Washington, D. C. (F. '07; H. F. '24). *Chalcidoidea.*
'14. Howard, Neale F., 151 West 11th Ave., Columbus, Ohio. *Mexican Bean Beetle.*
'31. Howe, Edwin W., P. O. Box 952, Santa Cruz, California. *Diptera, Trypetidae, Ortalidae.*
'20. Huckett, H. C., Long Is. Vegetable Res. Farm, Riverhead, L. I., N. Y. *Muscidae.*
'30. Hughes, Miss Gwladys F., 4108 Springdale Ave., W. Forest Park, Baltimore, Md. *Odonata.*
'16. HUNGERFORD, H. B., 323 Snow Hall, Univ. Kansas, Lawrence, Kans. (F. '27). *Aquatic Hemiptera.*
'36. Hurlbut, Herbert S., Comstock Hall, Cornell Univ., Ithaca, N. Y.
'34. Hussey, Priscilla B., Professor of Biology, Louisiana State Normal College, Natchitoches, La. *Hemiptera.*
'29. Hutchins, Annie Laurie, (Mrs. R. E.), Box 184, State College, Miss. *Coccidae.*
'30. Hutchins, Ross E., Box 184, State College, Miss. *Lepidoptera.*
'08. HYSLOP, JAMES A., Silver Spring, Maryland. (F. '35). *Elateridae.*

I

'31. Ide, F. P., Dept. Biol., Univ. Toronto, Toronto 5, Ont., Canada. *Ephemeroptera.*
'19. *Illingworth, J. F., Bishop Museum, Honolulu, Hawaii. *Muscoidea.*
'28. Ingram, J. W., Box 387, Houma, La. *Sugarcane Insects.*
'14. ISELY, DWIGHT, 3 North Duncan St., Fayetteville, Ark. (F. '34). *Chrysomelidae, Curculionidae.*
'36. Isely, F. B., Trinity Univ., Waxahachie, Texas. *Acrididae.*
'22. Ishimori, Naoto, Faculty Agri., Imp. Univ., Hongo, Tokyo, Japan. *Silkworn Diseases.*
'33. Issiki, Syuti, Taihoku Imperial Univ., Taihoku, Formosa, Japan.
'27. Ives, J. D., Jefferson City, Tenn. *Cave Insects.*
'34. Ivy, Edward E., Dept. of Entomology, State Agri. College, Stillwater, Okla.

J

'36. Jackman, Donald L., 3542 Emerson Ave. S., Minneapolis, Minn.
'37. Jacob, John K., 2978 W. 38th Ave., Vancouver, British Columbia, Canada.
'31. James, Maurice T., Dept. of Ent., Colorado State College, Ft. Collins, Colo. *Stratiomyiidae.*
'30. James, Melvin J., Texas Experiment Station, Winter Haven, Texas. *Economic Entomology.*
'35. Jaques, Harry E., Iowa Wesleyan College, Mount Pleasant, Iowa. *Insect Ecology.*
'30. Jaynes, H. A., Bureau of Ent. and P. Q., Moorestown, N. J. *Tiphia of S. A.*
'25. JEANNEL, RENE, Mus. d'Histoire Naturelle, 45 bis rue de Buffon, Paris 5e, France. (F. '30). *Trechus, Anophthalmes.*
'36. Jen, Ming-Tao, Div. of Entomology, Univ. Farm, St. Paul, Minn.
'10. Jennings, H. R., High School of Com., Hayes and Van Ness Ave., San Francisco, Cal. *Diptera.*
'15. Jewett, H. H., Agri. Exp. Sta., Lexington, Ky. *Sod webworm, wireworms.*
Ch. JOHANNSEN, O. A., Dept. Ent., Cornell Univ., Ithaca, N. Y. (F. '14). *Diptera.*
'25. Johnson, Frank, 420 Lexington Ave., New York, N. Y.
'26. Johnston, H. G., Ent. Dept., College Station, Texas. *Miridae, Hemiptera.*
'27. Jones, Elmer T., 1204 Fremont, Manhattan, Kansas. *Hessian Fly.*
Ch. Jones, Frank M., 2000 Riverview Ave., Wilmington, Delaware. *Psychidae.*
'35. Jones, Harold C., Mount Berry, Georgia. *Membracidae.*
'30. Jones, S. E., Winter Haven, Texas. *Truck Crop Insects.*

K

'34. Kagy, J. Franklin, Citrus Exp. Station, Riverside, Calif. *Insect Toxicology.*
'16. Kahl, Hugo, Carnegie Museum, Pittsburgh, Pa. *Odonata.*
'26. Kamal, Mohammed, Cotton Research B., Giza, Egypt. *Cotton Insects.*
'30. Kato, Shizuto, Section of Entomology, Hokkaido Agri. Exp. Sta., Kotoni, Sapporo, Japan. *Muscidae, Agromyzidae, Chloropidae.*
'34. Kearns, Clyde W., Illinois Natural History Survey, Urbana, Ill. *Insecticides.*
'29. Keck, Chester B., Box 340, Honolulu, Hawaii. *Ecology.*
'14. KENNEDY, C. H., Dept. Zool. and Entomology, Ohio State University, Columbus, Ohio. (F. '27). *Odonata.*
'36. Kessel, Berta B., 21 Manor Terrace, Mill Valley, Calif.
'37. Kim, Hun Hyu, 153 Institute Place, Chicago, Ill. *Anobiidae.*
Ch. Kincaid, Trevor, Univ. Washington, Seattle, Wash. *Psychodidae, Dytiscidae.*
'12. KING, J. L., Box 150, Moorestown, New Jersey. (F. '32). *Biological Control.*
'23. King, Kenneth M., Dominion Entomological Laboratory, Saskatoon, Sask., Canada. *Elateridae larvae, Noctuidae.*
'28. King, Willard V., Box 491, Orlando, Florida.
'18. KINSEY, ALFRED C., Indiana University, Bloomington, Ind. (F. '28). *Cynipidae.*
'28. Kislanko, J. P., Box 88, Wiggins, Miss. *Aphididae.*
'32. Klein, Adolph, 370 Lexington Ave., New York, N. Y. *Odonata.*
'11. KNIGHT, H. H., Dept. Zool., St. College, Ames, Iowa. (F. '28). *Hemiptera, Miridae.*
'30. Knipling, Edward, P. O. Box 508, Valdosta, Georgia. *Muscoidea.*
'24. Knowlton, George F., Agri. Exp. Sta., Logan, Utah. *Aphididae.*
'32. Knull, Mrs. Dorothy, 321 Twentieth Ave., Columbus, Ohio. *Erythroneura.*
'34. Knull, Josef N., 321 Twentieth Ave., Columbus, Ohio. *Cleridae, Elateridae, Buprestidae, Cerambycidae.*
'37. Knutson, Herbert C., Div. of Entomology, Univ. Farm, St. Paul, Minn. *Noctuidae.*
'17. Kraatz, Walter C., University of Akron, Akron, Ohio.
'34. Krombein, Karl Von Vorse, 22 Meadow View Place, Buffalo, N. Y. *Aculeate Hymenoptera.*
'36. Kulash, Walter M., P. O. Box 97, Haydenville, Mass. *Diptera.*
'34. Kuster, Kimber C., State Teachers College, Bloomsburg, Pa. *Stratiomyiidae.*
'23. Kuwayama, Satoru, Hokkaido Agri. Exp. Sta., Kotoni, Sapporo, Japan. *Neuroptera, Trichoptera, Psyllidae.*

L

'14. Laake, E. W., Box 208, Dallas, Texas. *Larval Muscidae, Oestridae.*
'20. LaCroix, Donald S., 25½ Pleasant S., Amherst, Mass. *Tobacco Insects.*
'28. Lamiman, J. F., Univ. Calif., Davis, Calif. *Acarina.*
'28. Lanchester, Horace, Box 5, College Place, Wash. *Elateridae.*
'30. Landis, B. J., 151 West Eleventh Ave., Columbus, Ohio. *Biological Control.*
Ch. Lang, Joseph N., 1433 S. 59th Ave., Cicero, Ill.
'25. Langford, George S., Dept. Ent., Univ. Maryland, College Park, Md.
'17. Langston, James M., A. & M. College, Miss. *Phyllophaga.*
'37. La Rivers, Ira, State College Station, Raleigh, North Carolina.
'14. Larrimer, W. H., U. S. D. A. Forest Service, Washington, D. C. *Cicadellidae.*
'37. Lassman, G. W., Apartado No. 549, Mexico, D. F., Mexico. *Culicidae.*
'13. Lathrop, F. H., Agric. Exp. Station, Orono, Maine. *Cicadellidae.*
'20. Lathy, Percy I., 90 Bd. Malesherbes, Paris, France. *Lepidoptera.*
'23. Lauderdale, J. L. E., Box 368, Yuma, Arizona.
Ch. Laurent, Philip, 31 East Mt. Airy Ave., Philadelphia, Pa.
'17. LAWSON, PAUL B., 2244 New Hampshire St., Lawrence, Kans. (F. '31). *Cicadellidae.*
'22. Learned, Elmer T., 42 Franklin St., Fall River, Mass. *Lepidoptera.*
'12. Leiby, R. W., Comstock Hall, Cornell Univ., Ithaca, N. Y. *Embryology.*
'28. Leonard, Mortimer D., John Powell & Co., Inc., 114 East 32nd St., New York City, N. Y. *Aphididae.*
'34. Le Veque, Norma, 921 13th St., Boulder, Colo. *Apoidea.*

'36. Levi, Alexander W., 1042 Western Ave., San Bernardino, Calif. *Orthoptera.*
'31. Lewis, Ralph H., 145 State St., Batavia, New York. *Thysanoptera.*
'35. Li, Feng-Swen, c/o Wang Sin Mao, Yun Shi Station, Canton-Hankow Railroad, Hunan, China. *Culicidae.*
'33. Lilly, John H., King Hall, Univ. of Wisconsin, Madison, Wisc. *Coleophoridae.*
'34. Lindgren, David L., Univ. of Calif., Citrus Exp. Sta., Riverside, Calif.
'17. Lindsey, A. W., Box 782, Granville, Ohio. *Hesperioidea.*
'32. Ling, Shao-wen, Dept. Biol., Univ. Amoy, Amoy, China. *Trichoptera.*
'33. *Linsley, E. Gorton, 112 Agricultural Hall, Univ. of California, Berkeley, Calif. *Cerambycidae of World, Coleoptera of N. Am.*
'25. List, Geo. M., Agri. College, Fort Collins, Colo. (F. '32). *Cimicidae.*
'30. Littell, Mrs. Dorothy D., 682 Princeton Blvd., Wilkinsburg, Pa.
'34. Liu, Chi-ying, Div. of Ent., Dept. of Agri., Chekiang Univ., Hangchow, China. *Siphonaptera.*
'24. Liu, Chung Lo, Div. of Ent., Instit. of Agric. Research, Nat'l. Tsing Hua Univ., Peiping, China. *Vespidae, Bombidae.*
'36. Liu, K. S., Div. of Ent., University Farm, St. Paul, Minn. *Noctuidae.*
'30. Livingston, E. M., 17 North Boulevard, Richmond, Va. *Thysanoptera, Orthoptera.*
Ch. Lloyd, J. T., 300 West Court St., Cincinnati, Ohio. *Trichoptera.*
'31. Lloyd, Llewellyn, University, Leeds, England.
'19. Lobdell, Mrs. Gladys H., Belle Glade, Fla. *Coccidae.*
'30. Loftin, U. C., Bureau Entomology, Washington, D. C.
'38. Lowrie, Raymond E., 48 State St., P. O. Box 114, New Bedford, Mass.
'13. Luginbill, Philip, Box 495, Lafayette, Ind. *Phyllophaga.*
'34. Lund, Horace O., Dept. of Zoology, Univ. of Georgia, Athens, Georgia. *Trichogramma.*
Ch. Lutz, Frank E., Am. Mus. Nat. Hist., 77th St. and Central Park West, New York City, N. Y. (F. '17). *Bees.*
'31. Lyle, Clay, State College, Miss. *Crustacea.*

M

'28. MacAloney, H. J., Box 701, New Haven, Conn. *Forest Insects.*
'28. MacAndrews, A. H., College of Forestry, Syracuse, N. Y. *Scolytidae.*
'36. MacCreary, Donald, Del. Agri. Exp. Sta., Newark, Delaware. *Tabanidae, Culicidae.*
'32. MacLeod, Guy F., Cornell University, Ithaca, N. Y. *Physiology.*
'20. McBride, O. C., Box 340, Honolulu, Hawaii. *Insecticides.*
'29. McClure, H. Elliott, Dept. Zool. and Ent., Iowa State College, Ames, Iowa. *Ecology.*
'17. McCracken, Isabel, Box 1545, Stanford University, Calif. *Cynipidae, Apoidea.*
'10. McDaniel, Eugenia, Agri. College, East Lansing, Mich. *Coccidae, Orthoptera.*
'12. McDunnough, J., Ent. Branch, Dept. Agri., Ottawa, Ont., Canada. (F. '20). *Lepidoptera, Ephemerida.*
'30. McGovran, E. R., Bureau of Ent. and Plant Quar., Nat. Agr. Res. Center, Beltsville, Md. *Toxicology.*
'25. McGregor, E. A., 724 Earlham Drive, Whittier, Calif. *Tetranychidae.*
'11. McIndoo, N. E., 7225 Blair Rd., Takoma Park, Washington, D. C. (F. '34). *Insect Physiology.*
'32. McKinstry, Arthur Porter, C. C. C. Co. 710, Middle River, Minn. *Microvelia.*
'35. Ma, Hsien-chen, Dept. of Biology, Lingnan Univ., Canton, China. *Medical Entomology.*
'32. Madden, A. H., Box 549, Quincy, Florida. *Economic Entomology.*
'34. Madden, Ruth A., 324 Stutsman St., Council Bluffs, Iowa.
'17. Maheux, Georges, Dept. Agri., Parliament Bldg., Quebec, Canada. *Forest Insects.*
'31. Mail, G. Allen, Dominion Entomological Laboratory, Kamloop, British Columbia, Canada. *Culicidae.*
'36. Malcomson, R. O., 1105 West Illinois St., Urbana, Ill. *Mallophaga.*

'33. Manis, Hubert C., Dept. of Ent., Iowa State College, Ames, Iowa. *Onion, Potato Insects.*
'21. *Mank, Edith Webster, 12 Reservoir St., Lawrence, Mass. *Coleoptera.*
'21. Mank, Helen G., 12 Reservoir St., Lawrence, Mass.
'13. *MANN, WM. M., Nat. Zool. Park, Washington, D. C. (F. '37). *Formicidae.*
'23. Manter, Jerauld A., Agri. College, Storrs, Conn. *Economic Entomology.*
'37. Manzelli, Manlio, 258 Netherwood Ave., Plainfield, N. J.
'35. Maple, John D., Univ. of Calif., Citrus Exp. Sta., Riverside, Calif. *Physiology.*
'22. Marcovitch, S., University Farm, Knoxville, Tenn. *Insecticides.*
'37. Markos, Basil G., Dept. Ent., Ohio State University, Columbus, Ohio. *Buprestidae.*
Ch. MARLATT, C. L., 1521 16th St., N. W., Washington, D. C. (F. '07). *Coccidae.*
Ch. MARSHALL, W. S., 139 E. Gilman St., Madison, Wisc. (F. '17). *Morphology.*
'25. Martin, Chas. H., Dept. of Ent., Cornell Univ., Ithaca, N. Y. *Diptera.*
'37. Martin, Rosemary D. C., 24 Hawthorne Ave., Toronto, Ontario, Canada. *Odonata.*
'34. Martorell, Luis F., P. O. Box 614, Rio Piedras, Puerto Rico. *Sugar Cane, Forest Insects.*
'21. Mason, Arthur C., Box 340, Honolulu, Hawaii. *Thysanoptera.*
'30. Mason, Horatio C., 151 West 11th Ave., Columbus, Ohio.
Ch. MATHESON, ROBT., Cornell Univ., Ithaca, N. Y. (F. '28). *Ixodoidea, Culicidae.*
'34. Mattingly, Father H. E., St. Charles Coll., P. O. Box 303, Columbus, Ohio. *Coleoptera.*
'34. Maxson, Asa C., Longmont, Colo. *Aphidae.*
'34. Maxwell, K. E., Div. of Entomology, Citrus Experiment Station, Riverside, Calif.
'36. Mead, Albert R., 1485 Franklin St., Santa Clara, Calif. *Chrysomelidae.*
'37. Medler, John T., Div. of Entomology, University Farm, St. Paul, Minn.
'25. Meiners, Edwin, 6600 Delmar Blvd., St. Louis, Mo. *Lepidoptera.*
'32. Melampy, R. M., Southern State Field Laboratory, University Station, Baton Rouge, La. *Physiology.*
Ch. MELANDER, A. L., City College of New York, New York, N. Y. (F. '14). *Diptera.*
'27. Melvin, Roy, Box 487, Menard, Texas. *Physiology.*
'33. Menusan, Henry, Jr., Cornell Univ., Ithaca, N. Y. *Physiology, Ecology.*
'32. Merino, Gonzalo, Bureau Plant Industry, Manila, P. Is. *Cicadellidae.*
'23. Merrill, G. B., Box 2877, University Station, Gainesville, Fla. *Coccidae, Aleyrodidae.*:
'12. METCALF, C. L., Nat. Hist. Bldg., Univ. Illinois, Urbana, Ill. (F. '20). *Syrphidae.*
'09. METCALF, Z. P., State College Station, Raleigh, North Carolina. (F. '34). *Homoptera.*
'35. Michelbacher, A. E., 112 Agri. Hall, Univ. of California, Berkeley, Calif. *Symphyla, Apoidea.*
'37. Michener, Charles D., 418 N. Hudson Ave., Pasadena, Calif.
'17. MICKEL, CLARENCE E., Div. Ent., Univ. Farm, St. Paul, Minn. (F. '35). *Mutillidae.*
'36. Miles, Virgil I., 210 East Bay St., c/o Malaria Research Laboratory, Savannah, Georgia. *Culicidae.*
'36. Miller, Albert, Comstock Hall, Cornell Univ., Ithaca, N. Y. *Pyralididae.*
'31. Miller, Albert C., Box 2038, Pittsburgh, Pa. *Membracidae.*
'28. Miller, D. F., State Univ., Dept. Zool., Columbus, Ohio. *Diptera.*
'30. Miller, Forrest W., Biology Dept., Hartwick College, Oneonta, New York. *Aphididae.*
'25. Miller, Warren C., 111 Ellenwood Ave., Bedford, Ohio. *Coleoptera.*
'37. Milliron, Herbert E., Dept. of Entomology, Michigan State College, East Lansing, Mich. *Chalcidoidea.*
'29. MILLS, HARLOW B., Dept. of Ent., Montana State College, Bozeman, Mont. (F. '37). *Collembola.*

'37. Milne, Lorus J., Randolph-Macon Woman's College, Lynchburg, Va. *Trichoptera.*
'25. Milum, Vern G., 104 Exp. Zool. Lab., Univ. of Illinois, Champaign, Ill. *Apiculture.*
'35. Minkiewich, Stanislaw, Dept. of Ent., Gov. Inst. for Agri. Research, Pulawy, Poland. *Tortricidae.*
'26. Minnich, D. E., Dept. Zool., Univ. Minn., Minneapolis, Minn. *Behavior.*
'21. MITCHELL, T. B., State College, Raleigh, North Carolina. (F. '37). *Apoidea, Megachile.*
'30. Miwa, Yushiro, Dept. Agri., Gov. Research Inst., Taihoku, Formosa. *Elateridae.*
'21. *Moffatt, Elizabeth M., 328½ N. Rampart, Los Angeles, Calif. *Araneida.*
'22. MONTGOMERY, B. ELWOOD, Dept. Ent., Purdue Univ., Lafayette, Ind. (F. '31). *Odonata.*
'34. Moore, Joseph B., Dept. of Ent., Cornell Univ., Ithaca, N. Y.
'08. MORGAN, ANN H., Mt. Holyoke College, South Hadley, Mass. (F. '37). *Ephemeridae.*
Ch. Morgan, H. A., 2424 Kingston Pike, Knoxville, Tenn.
'27. Morgan, W. P., 4115 Otterbein Ave., Indianapolis, Ind. *Dermaptera.*
Ch. Morrill, A. W., 1505 Winchester Ave., Glendale, Calif.
'12. MORRISON, HAROLD, Bureau of Entomology and Plant Quarantine, Washington, D. C. (F. '28). *Coccidae.*
'08. MOSHER, EDNA, Adelphi College, Garden City, N. Y. (F. '20). *Lepidoptera.*
'20. Mote, Don C., St. Agri. College, Corvallis, Oregon. *Aquatic Insects.*
'29. MOULTON, DUDLEY, 35 Elwood St., Redwood City, Calif. (F. '31). *Thysanoptera.*
'15. MUESEBECK, C. F. W., Bureau of Entomology and Plant Quarantine, Washington, D. C. (F. '34). *Braconidae, Bethylidae.*
'36. Mulrennan, J. A., State Hygenic Laboratory, Austin, Texas. *Culicidae.*
'30. Mundell, R. C., Care of Banco de Londres, America del Sud, Las Heras, 616, Tucuman, Argentina. *Parasitic Hymenoptera.*
'24. Munro, H. K., Box 513, Pretoria, South Africa. *Trypetidae, Diptera.*
'27. Munro, J. A., State College Station, Fargo, North Dakota. *Orthoptera, Diptera.*
'37. Munson, Sam C., 2300 G. St., N. W., Washington, D. C. *Insect Physiology.*
'35. Murray, William D., Div. Ent., Univ. of Minnesota, St. Paul, Minn. *Sphecidae, Ichneumonidae.*
'28. Musgrave, Anthony, Australian Museum, College St., Sydney, New South Wales, Australia. *Nycteribiidae.*
'27. Musgrave, Paul N., 514 Mt. Vernon Ave., Fairmont, West Va. *Chrysomelidae.*
'17. MUTCHLER, A. J., Am. Mus. Nat. Hist., 77th St. and Central Park West, New York City, N. Y. (F. '35). *Coleoptera.*
'15. Muttkowski, R. A., Univ. Detroit, Detroit, Mich. *Physiology, Ecology.*

N

'35. Nagel, R. H., Forest Service, Plankinton Bldg., Milwaukee, Wisc. *Phyllophaga.*
'35. Naude, Theunis J., Chief Entomologist, Dept. of Agri., P. O. Box 513, Pretoria, Union of S. Africa. *Cicadellidae.*
Ch. NEEDHAM, J. G., 6 Needham Place, Ithaca, N. Y. (F. '07; H. F. '35). *Odonata, Ephemerida.*
'21. Neiswander, C. R., Ohio Agri. Exp. Sta., Wooster, Ohio. *Insects of ornamentals.*
'28. Neiswander, R. B., Agri. Exp. Sta., Wooster, Ohio. *Fruit Insects.*
'07. Nelson, J. A., Gambier, Ohio.
Ch. Ness, Henry, 821 Kellogg Ave., Ames, Iowa.
'36. Nettleton, 2nd, Geo. E., Mt. Pleasant Inn., Pleasant St., Amherst, Mass. *Braconidae.*
'34. Nevin, F. Reese, Roberts Hall, Cornell Univ., Ithaca, N. Y. *Morphology of Acarina.*
Ch. Newcomb, Wm. W., 1245 Ferdon Rd., Ann Arbor, Mich. *Lycaenidae, Noctuidae.*

Ch. Newcomer, E. J.. Box 243, Yakima, Washington. *Fruit Insects.*
'07. Newell, Wilmon, St. Plant Bd., Gainesville, Fla.
'15. Newman, Geo. B., 246 E. Hamilton Ave., State College, Pa. *Insect Histology.*
'28. Newton, Richard C., 518 Haven St., Medford, Oregon. *Trichoptera.*
'31. Nickels, C. B., Box 209, Bureau of Entomology, Brownwood, Texas. *Pecan Insects.*
'22. Noble, W. B., Box 495, U. S. Ent. Lab., Lafayette, Ind. *Hessian Fly.*
'17. *Notman, Howard, Circle Rd., Dougan Hills, Staten Island, N. Y. *Carabidae, Staphylinidae.*
'37. Nye, William P., Dept. of Entomology, Utah Agri. Coll., Logan, Utah. *Forest Insects.*

O

'31. O'Bryne, Harold I., 606 West Iowa St., Urbana, Illinois. *Lepidoptera, Hesperidae.*
'08. O'KANE, WALTER C., Durham, New Hampshire. (F. '24).
'29. Oman, Paul W., Div. Insects, Nat. Mus., Washington, D. C. *Homoptera.*
'37. O'Neill, William J., 94 Church St., New Brunswick, N. J. *Biological Control.*
'34. Oosthuizen, M. J., School of Agriculture, Potchefstroom, South Africa. *Economic Entomology.*
'35. Orr, Leslie W., Bureau of Ent. and P. Q., Washington, D. C. *Forest Insects.*
Ch. OSBORN, HERBERT, State Univ., Columbus, Ohio. (F. '07; H. F. '28). *Homoptera, Cicadellidae.*
'08. Osborn, H. T., Rockefeller Institute, Princeton, New Jersey. *Insects and Plant Diseases.*
Ch. OSBURN, R. C., State Univ., Columbus, Ohio. (F. '17). *Syrphidae.*
'20. Otanes, Faustino Q., Bureau of Plant Industry, Manila, Philippine Islands. *Coccidae.*
'36. Owen, Wm. Bert, Dept. of Zool., Univ. of Wyoming, Laramie, Wyo. *Culicidae.*
'25. Ozburn, Reg. H., Ontario Agri. College, Guelph, Ontario, Canada. *Insect Histology.*

P

'15. Packard, Clyde M., Bureau of Ent. and Plant Quar., Washington, D. C. *Cereal and Forage Insects.*
'18. Painter, H. R., Box 495, Lafayette, Indiana. *Acrididae.*
'19. PAINTER, R. H., Dept. Ent., K. S. C., Manhattan, Kansas. (F. '35). *Diptera, Bombyliidae.*
'23. Pallister, John, 3754 Independence Road, Cleveland, Ohio. *Coleoptera.*
'37. Palmer, Boyd B., Polytechnic Institute, San German, Puerto Rico.
'27. PALMER, MIRIAM A., Dept. Ent., Agri. College, Fort Collins, Colo. (F. '37). *Aphidae.*
'33. Parish, H. E., Box 487, Menard, Texas.
'27. Park, Orlando, Dept. Zool., Northwestern Univ., Evanston, Ill. *Pselaphidae.*
'24. Parker, Donald L., 24 Jefferson Ave., Morristown, New Jersey.
'25. Parker, H. L., European Parasite Laboratory, 61 Ave. Alfred Balmontet, St. Cloud, S. & O., France. *Behavior.*
'18. Parker, J. B., Catholic University of America, Washington, D. C. *Bembicidae.*
'37. Parker, J. R., Bureau of Ent. and Pl. Quar., Bozeman, Montana. *Orthoptera.*
'24. Parker, R. L., Dept. Ent., K. S. C., Manhattan, Kansas. *Apiculture.*
'34. Parks, Hal B., Austin College, Nacogdoches, Texas. *Diptera, Hymenoptera.*
'16. Parks, H. B., Route 1, Box 368, San Antonio, Texas. *Apiculture.*
'18. Parks, T. H., Dept. Ent., State University, Columbus, Ohio.
'24. Parman, D. C., Box 509, Uvalde, Texas. *Diptera.*
Ch. PARROTT, P. J., Agri. Exp. Sta., Geneva, N. Y. (F. '14).
'12. Parshley, H. M., Dept. Zool., Smith College, Northampton, Mass. *Heteroptera.*
'32. Parsons, Carl T., 205 West 57th St., New York City, N. Y.

'34. Parten, Herbert L., Div. of Ent., Univ. Farm, St. Paul, Minn. *Greenhouse Insects.*
'32. Passos, Cyril F. dos, Washington Corners, Mendham, N. J. *Lepidoptera.*
Ch. *PATCH, EDITH M., Agri. Exp. Sta., Orono, Maine. (F. '14). *Aphididae.*
'25. Patch, L. H., 705 Brighton Ave., Toledo, Ohio. *European Corn Borer.*
'35. Paulian, Renaud, 9 rue Augusto Lancon, Paris XIII, France. *Coleoptera and Insect Growth.*
'35. Paullus, Harold J., Crystal City, Mo.
Ch. Paxson, Owen S., Radnor, Delaware Co., Pa.
'23. Payne, Nellie M., c/o American Cyanamide Co., Boston Post Road, Stamford, Conn. *Physiology.*
'20. Peairs, L. M., Morgantown, West Va.
'34. Pechuman, La Verne L., Dept. of Entomology, Cornell Univ., Ithaca, N. Y. *Tabanidae.*
'37. Pelton, John Z., 94 E. Tulane Road, Columbus, Ohio. *Aquatic Insects.*
'35. Penner, Lawrence R., Dept. of Entomology, Univ. Farm, St. Paul, Minn. *Delphacidae.*
'30. Pepper, Bailey B., Dept. Ent., Agri. Exp. Sta., New Brunswick, N. J. *Biological Control.*
'32. Pepper, James Hubert, Montana State College, Bozeman, Mont.
'29. Peters, Harold T., 500 S. Minn. Ave., Sioux Falls, S. D. *Xestocephalus.*
'11. PETERSON, ALVAH, Dept. Ent., Ohio State University, Columbus, Ohio. (F. '28). *Diptera.*
'37. Peterson, Lloyd O. T., Indian Head, Saskatchewan, Canada.
Ch. Petit, R. H., Dept. Ent., Michigan State College, East Lansing, Mich. *Coccidae.*
'07. PETRUNKEVITCH, ALEXANDER, Yale Univ., New Haven, Conn. (F. '37). *Arachnida.*
'21. PHILLIPS, E. F., Cornell Univ., Ithaca, N. Y. (F. '29). *Apiculture.*
'12. Phillips, W. J., 737 Lexington Ave., Charlottsville, Va. *Harmolita.*
'37. Phillips, W. Levi, 985 South Third East, Salt Lake City, Utah. *Coleoptera, Lepidoptera.*
Ch. PIERCE, W. DWIGHT, Los Angeles County Museum, Exposition Park, Los Angeles, Calif. (F. '30). *Rhynchophora.*
'35. Pinkus, L. F., 6307 Alexander Drive, St. Louis, Mo. *Arachnida.*
'28. Plummer, C. C., Calzada Tucuba 295, Colonia Anahuac, Mexico, D. F., Mexico. *Membracidae.*
'18. Poos, Fred W., Arlington Farm, Rosslyn, Va.
'23. Porter, B. A., Bureau Entomology, Washington, D. C. *Fruit Insects.*
'34. Post, R. L., Dept. of Ent., Ward's Nat. Sci. Est., Rochester, N. Y. *Staphylinidae.*
'26. Potts, Samuel F., 56 Hillhouse Ave., New Haven, Conn. *Toxicology, Physiology.*
'37. Powell, Dwight, 1106 S. Locust St., Champaign Ill. *Insecticides.*
'25. Powell, Eugene F., 125 Bessey Hall, Univ. Nebraska, Lincoln, Nebr. *Chrysomelinae.*
'36. Pratt, Harry D., 125 Hall St., North Adams, Mass. *Ichneumonidae.*
'16. Price, W. A., Univ. Kentucky, Lexington, Ky. *Economic Entomology.*
'32. Pritchard, A. Earl, Div. of Ent., Univ. Farm, St. Paul, Minn. *Asilidae.*
'28. Procter, Wm., Bar Harbor, Maine.
'33. Putman, W. L., Dom. Ent. Lab., Vineland Station, Ontario, Canada. *Chrysopidae.*

Q

'36. Quarterman, Kenneth D., 1010 Travis Bldg., San Antonio, Texas. *Cimicidae.*

R

'14. RAU, PHIL, 549 E. Argonne Drive, Kirkwood, Mo. (F. '27). *Hymenoptera, Behavior.*
'23. READIO, PHILIP A., Dept. of Ent., Cornell Univ., Ithaca, N. Y. (F. '37). *Reduviidae.*
'23. Reed, W. D., 17 North Boulevard, Richmond, Va. *Tobacco Insects.*

'30. Rees, Don M., Univ. Utah, Salt Lake City, Utah. *Culicidae.*
'23. Reeves, Jos. A., Senior High School, St. Petersburg, Fla. *Chrysomelidae, Fulgoridae.*
'08. Regan, W. S., 2908 Summit View, Yakima, Washington.
Ch. REHN, J. A. G., Acad. Nat. Sciences, Logan Square, Philadelphia, Pa. (F. '14). *Dermaptera, Orthoptera.*
'34. Rice, Paul L., Alma College, Alma, Mich. *Chalcidoidea.*
'30. Richards, A. Glenn, Jr., Biology Dept., College of the City of New York, 17 Lexington Ave., New York, N. Y. *Noctuidae.*
'14. RICHARDSON, CHAS. H., Dept. Ent., Iowa State College, Ames, Iowa. (F. '31). *Physiology.*
'29. Richardson, H. H., Beltsville Research Center, Beltsville, Maryland. *Physiology.*
'37. Richins, Calvin A., Dept. of Zool., University Park, Los Angeles, Calif.
'28. Richmond, Edward A., Agri. Exp. Sta. Bldg., State College, Pa. *Hydrophilidae.*
'22. Ries, Donald T., 401 Thurston Ave., Ithaca, N. Y. *Cephidae, Siricidae.*
'29. Riley, Merrill K., Box 1478, Honolulu, Hawaii. *Coccidae.*
Ch. RILEY, WM. A., Div. Ent., Univ. Farm, St. Paul, Minn. (F. '14). *Parasitology.*
'33. Ritcher, Paul O., Agri. Exp. Station, Lexington, Ky. *Phyllophaga.*
'36. Ritchie, C. L., Rt. 1, Box 245 A., Chula Vista, Calif.
'25. Rivnay, Ezekiel, Agri. Exp. Sta., Rehoboth, Palestine. *Thysanoptera.*
'31. Roberts, J. Harvey, Box 376, Univ. Station, Baton Rouge, La. *Trichoptera.*
'28. Roberts, R. A., P. O. Box 178, Gainesville, Florida. *Diptera.*
'15. Robinson, J. M., Box 671, Auburn, Alabama. *Coccidae, Coleoptera.*
'26. Robinson, Wm., Burnt Mills Hills, Silver Spring, Maryland. *Physiology.*
'13. Rockwood, L. P., Forest Grove, Oregon. *Noctuidae, Orthoptera.*
'31. Rodeck, Hugo G., Univ. Colorado Museum, Boulder, Colo. *Nomada.*
'15. Rogers, J. Speed, Box 2666, Univ. Sta., Gainesville, Fla. *Tipulidae.*
'27. ROHWER, S. A., Bur. Ent., Washington, D. C. (F. '29). *Hymenoptera.*
'14. Rosenfeld, A. H., Cotton Research Board Bldg., Giza, Egypt.
'25. Rosewall, O. W., Dept. Ent., St. Univ., Baton Rouge, La. *Coleoptera, Pentatomidae.*
'31. ROSS, HERBERT H., State Natural History Survey, Urbana, Ill. (F. '37). *Tenthredinoidea.*
'12. Ross, Wm. A., Vineland Station, Ontario, Canada. *Aphididae.*
'36. Rozeboom, Lloyd Eugene, Dept. of Ent.-Zool., Oklahoma Agri. College, Stillwater, Okla. *Culicidae.*
'14. Ruckes, Herbert, 167-11 33rd Ave., Flushing, Long Island, New York. *Pentatomidae.*
Ch. Ruggles, A. G., University Farm, St. Paul, Minn. (F. '35).
Ch. Rumsey, W. E., 443 Park St., Morgantown, West Va.

S

'33. *Sabrosky, Curtis W., Dept. of Ent., Mich State Coll., East Lansing, Mich. *Chloropidae.*
'29. Sakimura, Kay, Pineapple Exp. Station, Honolulu, Hawaii. *Thysanoptera.*
'23. Salman, Kenneth A., 335 Giannini Hall, Univ. California, Berkeley, Calif. *Forest Insects.*
'37. Sampson, William W., 112 Agri. Hall, Univ. California, Berkeley, Calif.
'32. Sanders, Geo. E., Sanders-Durling Entomological Service, Guardian Life Bldg., 50 Union Square, New York, N. Y. *Insecticides.*
Ch. SANDERS, J. G., c/o Sun Oil Co., 1608 Walnut St., Philadelphia, Pa. (F. '20).
'31. Sanderson, Milton W., Dept. of Ent., Univ. of Arkansas, Fayetteville, Ark. *Parnidae.*
'33. Sandhouse, Grace A., Room 378, U. S. Nat. Museum, Washington, D. C. *Apoidea.*
'31. Sargent, Wm. D., Orchard Lane, Westport, Connecticut. *Trichoptera.*
'07. SATTERTHWAIT, A. F., Box 32, Urbana, Illinois. (F. '30). *Calendra.*
'29. Scaramuzza, L. C., Central Baragua, Prov. of Camaguay, Cuba. *Sugar Cane Insects.*

'30. Schaefer, Paul E., Dept. Ent., Ohio State University, Columbus, Ohio. *Morphology.*
'25. Schear, E. W. E., 107 W. Park St., Westerville, Ohio. *Hemiptera, Diptera, Hymenoptera.*
'30. Schlosberg, Morris, 1920 Parkwood Ave., Toledo, Ohio. *Lepidoptera.*
'29. Schmidt, Carl T., Box 3166, Honolulu, Hawaii. *Ecology.*
'33. Schmidt, Helen D. O'Neil, Box 3166, Honolulu, Hawaii.
'20. Schmieder, Rudolf G., Zool. Lab., Univ. Pennsylvania, Philadelphia, Pa.
'32. Schmitt, John B., 411 White Horse Ave., Trenton, N. J. *Morphology.*
'34. Schmitt, Thomas H., Jr., 925 E. Howard St., Pasadena, Calif. *Scolytidae.*
Ch. Schoene, W. J., Agri. Exp. Sta., Blacksburg, Va.
'36. Schoof, Herbert F., State College Station, Raleigh, N. C. *Chrysomelidae.*
'29. Schroeder, H. O., Box 667, Ames, Iowa. *Ixodoidea, Argasidae.*
'37. Schroeder, Philip M., 1979 Ashland Ave., St. Paul, Minn. *Forest Insects.*
'32. Schumaker, George K., 1949 West Main St., Jeffersonville, Pa. *Stored Grain Insects.*
'26. SCHWARDT, H. H., 714 Douglas St., Fayetteville, Ark. (F. '35). *Tabanidae.*
'25. Schwarz, Eugene W. K., 9747 Shore Rd., Brooklyn, N. Y.
'26. SCHWARZ, HERBERT F., Am. Mus. Nat. Hist., 77th St. and Cent. Park West, New York City, N. Y. (F. '37). *Apoidea.*
'28. Scotland, Minnie B., 42 Continental Ave., Cohoes, N. Y. *Hydroporus.*
'25. Scullen, H. A., 325 So. 13th St., Corvallis, Oregon. *Hymenoptera.*
'23. Seamans, H. L., Dom. Ent. Lab., Lethbridge, Alberta, Canada. *Muscoidea.*
'36. Seevers, Charles, Dept. Zoology, University of Chicago, Chicago, Ill. *Aleocharinae.*
'22. Sellers, Wendell F., 61 Avenue Belmontet, St. Cloud, France. *Tachinidae.*
'29. Setty, L. R., Park College, Parkville, Mo. *Mecoptera, Bittacus.*
'08. Severin, H. C., South Dakota State College, Brookings, South Dakota. *Orthoptera, Homoptera, Heteroptera.*
'37. Shadle, Albert R., 143 University Ave., Buffalo, N. Y. *Coleoptera.*
'07. Shafer, Geo. D., 321 Melville Ave., Palo Alto, Calif. *Physiology.*
'18. *SHANNON, R. C., Caiza Postal 49, Rio de Janeiro, Brazil. (F. '34). *Diptera.*
'35. Shaw, Frank R., Fernald Hall, Massachusetts State College, Amherst, Mass. *Mycetophilidae.*
'29. Shaw, John G., Laboratorio Entomologico, Calzada Mexico–Tacuba 295, Colonia Anahuac, Mexico, D. F.
Ch. SHELFORD, V. E., Vivarium Bldg., Wright and Healy Sts., Champaign, Ill. (F. '20). *Ecology.*
'22. Shepard, Harold H., Univ. Farm, St. Paul, Minn. *Hesperiidae.*
'17. Sherman, Franklin, Div. Ent., Clemson College, South Carolina. *Acrididae, Cerambycidae, Cicindelidae.*
'11. Sherman, John D., Jr., 132 Primrose Ave., Mt. Vernon, N. Y. *Dytiscidae.*
'34. Shields, S. E., Box 1041, Ft. Pierce, Florida. *Culicoides.*
'35. Shockley, Wilfred, Darby, Montana. *Cerambycidae.*
'28. Shropshire, Leslie H., 1883 Miner St., Des Plaines, Ill. *Economic Entomology.*
Ch. Shull, A. Franklin, 431 Highland Rd., Ann Arbor, Mich. *Aphididae.*
'29. Shull, W. E., Dept. Ent., Univ. Idaho, Moscow, Idaho. *Insect Blood.*
'31. Siddall, Cameron, Freeport, Texas. *Meloidae.*
'15. SILVESTRI, FILIPPO, Scuola Superiore d'Agricoltura. Portici, Italy. (F. '20). *Thysanura, Protura, Termites, Myriapoda.*
'32. Silvey, J. K. Gwynn, Dept. of Biology, North Texas State Teacher's College. Denton, Texas. *Coleoptera.*
'32. Simanton, Wm. A., Gulf Research and Devel. Corporation, Susquehanna, P. O. Box 2038, Pittsburgh, Pa.
'35. Simizu, Tunehisa, Imp. Pl. Quar. Serv., Nagoya Custom House, Nagoya, Japan. *Bruchidae, Diptera.*
'29. Simmons, Perez, 712 Elizabeth St., Fresno, California. *Nitidulidae.*
'30. Simmons, S. W., Bureau Entomology and Plant Quarantine, Box 667, Ames, Iowa. *Medical Entomology.*
'25. Simons, Mrs. Carrie L., 4021 Alameda Drive, San Diego, Calif.
'30. *Simpson, Geddes W., Holmes Hall, Orono, Maine. *Insect and Plant Diseases.*
'32. Smith, Carroll N., Box 115, Vineyard Haven, Mass. *Ixodidae.*

'32. Smith, Chas. E., Louisiana Exp. Sta., Baton Rouge, La. *Truck Crop Insects.*
'35. Smith, Clyde F., Dept. of Entomology, Ohio State University, Columbus, Ohio. *Aphididae.*
'27. Smith, Floyd F., Bureau of Entomology, Washington, D. C. *Aphididae.*
'35. Smith, Frank K., Centennial High School, Pueblo, Colo. *Aquatic Coleoptera.*
'37. Smith, Gordon E., Health Section, T. V. A., Wilson Dam, Alabama. *Culicidae.*
'28. Smith, Herbert D., 61 Ave. Alfred Belmontet, St. Cloud, S-et-O., France. *Ichneumonidae.*
'35. Smith, Howard W., Box 21, New Ipswich, New Hampshire. *Diptera.*
'37. Smith, Marion E., Dept. of Ent., University of Illinois, Urbana, Ill. *Apantesis.*
'19. Smith, Marion R., Dept. of Entomology, Agricultural College, Mississippi. *Formicidae.*
'36. Smith, Ralph H., Univ. of California, 405 Hilgard Ave., Los Angeles, Calif. *Hemiptera.*
'14. SMITH, ROGER C., Dept. Ent., K. S. C., Manhattan, Kansas. (F. '31). *Neuroptera.*
'30. Smyth, E. Graywood, Hacienda Cartavio, Trujillio, Peru, S. A. *Cicindelidae.*
'18. Snapp, Oliver I., Box 527, Fort Valley, Georgia. *Rhynchophora.*
'24. SNODGRASS, R. E., 3706 Thirteenth St., N. W., Washington, D. C. (F. '27). *Morphology.*
'36. Snyder, Fred M., Dept. Econ. Ent., Univ. of Wisconsin, Madison, Wis. *Muscoidea.*
'26. Sorenson, Chas. J., Agri. Exp. Sta., Logan, Utah. *Membracidae.*
'14. *Spencer, G. J., Univ. Brit. Col., Vancouver, Brit. Col., Canada. *Trypetidae.*
'19. SPENCER, HERBERT, Bureau of Ent. and Plant Quarantine, P. O. Box 491, Orlando, Fla. (F. '37). *Citrus Insects.*
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